The science news monthly

SCIENCE DIGEST

JUNE 1965 35 CENTS ICD

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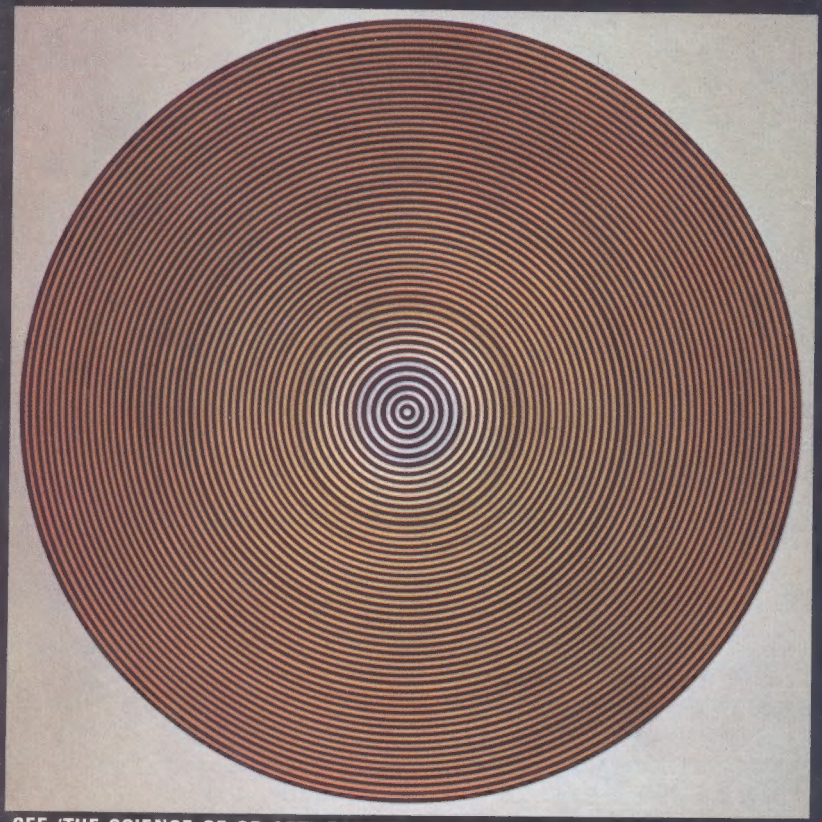

SEE 'THE SCIENCE OF OP ART'-PAGE 9

Also: Should we be serious about UFO's?
How your body can shape your personality
The amazing, new Cape Kennedy in pictures

UPI

The world's first 'leopons'

A "LEOPON" is a cross between a leopard and a lion. Here, in Tokyo's Hanshin Park Zoo, are the world's first—a male playfully nipping the neck of his sister.

When Hanshin Park Zoo director Yiroyuki Doi announced his plan to mate a lion with a leopard, experts claimed it was impossible because of the disparity in size and also because of their natural enmity.

A snarling, ill-tempered male leopard and a lioness weighing almost twice his weight were placed in the same quarters when they were barely a year old. Doi gave them hormones and a special diet. They finally mated, and the lioness produced the litter of "leopons" shown in the picture above.

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"SCIENTISTS create the gigantic mushroom over the desert, locate activity ten billion light years out in space, and prove the existence of a particle that lives only one ten billionth of a second—yet when we ask them to tell us about it, they often reply in language that simply bewilders us."

So write the editors of a recently published book (*Listen to Leaders in Science,* David McKay Company, New York, $5.50) in the book's foreword. The editors then proceed to find exceptions to the rule and offer eighteen brilliantly written (and presumably edited) statements by scientists on what their own sciences are all about.

THIS MONTH

The roster is a dazzling list including physicist Robert Oppenheimer, chemist (and AEC Chairman) Glenn T. Seaborg and oceanographer Roger Revelle (page 57).

A fellow physicist has called Oppenheimer's words "this profound and moving statement of one man's love of physics." In one passage, Oppenheimer tells of young men who ask him what satisfaction, after some years in physics, he still realizes in being a physicist.

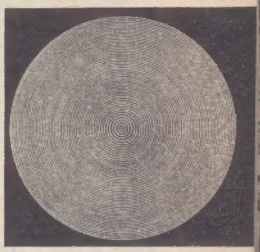
"For this question," Oppenheimer writes, "the answer is easy—I love to understand."

In putting together this and every other issue of *Science Digest,* we assume that you do, too.

THE EDITORS

SCIENCE DIGEST

Twenty-ninth year of publication



The spinning of "A-101," by Tadasky, is in your own eyes. Fooling our gullible eyes is the sly aim of a whole new school of Op Art. How we are taken in is explained in the report starting on page 9.

Photo: From "The Responsive Eye" show, The Museum of Modern Art, New York.

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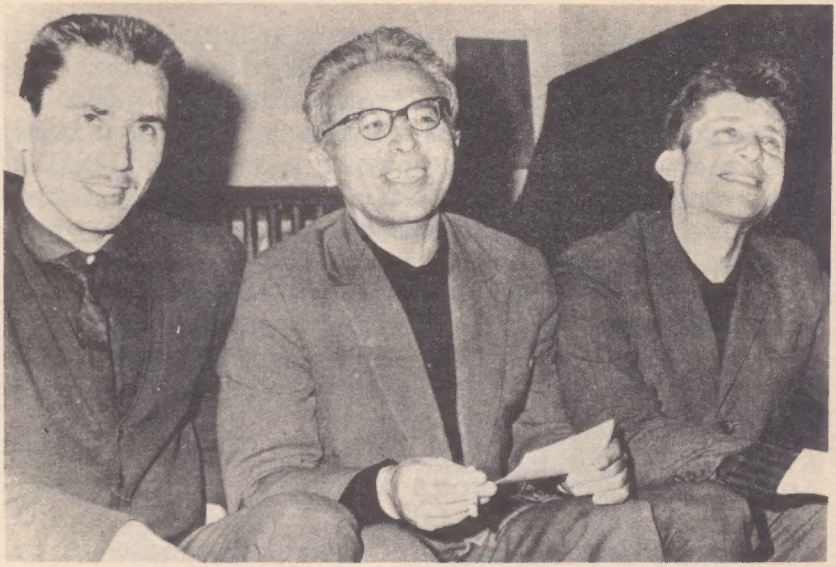
THE LATE SCIENCE NEWS

EVOLUTION CONTROVERSY. Sharp scientific disagreement erupted at a conference on the evolution of man held at the University of Chicago. On one side was Dr. Louis S. B. Leakey, British anthropologist, whose many fossil finds in Olduvai Gorge, Tanzania and other places in East Africa have helped rewrite the early history of man. Dr. Leakey said he has found evidence that three species of manlike creatures lived in the same area at the same time. Two of the species, Zinjanthropus and homo habilis, are well known. The third species, represented by a small fossil skull nicknamed George, was shown for the first time at the conference. A group of American anthropologists, led by Dr. John T. Robinson of the U. of Wisconsin, said that there are only two types of primitive men: The line represented by Zinjanthropus became extinct and the line represented by homo habilis probably evolved into modern man. George, he contended, is too like homo habilis to merit a new name or new species.

MOON TIME MISTAKE. New computations by a team of mathematicians using a huge electronic computer over a period of five years disclosed that there is an error of .3 second in the moon's previously calculated time schedule. This may be a clue to the moon's mass, but the error is too small to have any effect on such practical problems as navigation on earth or in space.



Wide World

IS CTA-102 CALLING? World scholars were startled when Tass, the official Russian news agency, announced that Soviet astronomers believed that they had received radio signals from "rational beings" on a distant planet. A few hours after the report went around the world, the three astronomers most concerned with it called a news conference. They said that the Tass announcement was premature. The three (above, left to right, Genaddy Sholomitsky, who found the flickering radio waves; Iosef S. Shklovsky, a world famous radio astronomer known for his interest in life on other worlds, and Nikolai Kardashev, who was said to have told Tass that the signals definitely were from another civilization) noted that the signals could be due to natural causes. The source of the unusual radio emissions was CTA-102, a spot in the constellation Pegasus (see Science Digest, Feb. '65).

MOON SURFACE FIRM NASA administrator James E. Webb reported to the President that pictures from Ranger IX (see page 22) gave strong indications that the moon's surface was firm enough to support a manned landing (see Science Digest, May '65). He said that because of the high resolution of the pictures, space experts "now know there are two spots--probably three--where we can land on the moon." But, he added, "we will need and get lots of other information" before two American astronauts land there.

LANDING IDEAS CHANGE. When the Apollo project began, the broad "marias" of the moon were considered to be the most likely landing sites. Now, due to the close-up photos from the three Ranger moon shots, a crater floor or highlands near a crater are considered more hospitable landing areas. The highlands appear to be smoother than had been expected; the marias, rougher.

DUST IN SPACE. The Mariner IV space probe is being pelted with more microscopic meteorites as it nears its rendezvous with Mars, July 14. The number of meteorites hitting the craft's detectors is nearly 10 times what it was late last year when the launching took place. Experts are unable to explain this increase in cosmic debris. One theory is that it comes from the asteroid belt which lies outside Mars' orbit.

COSMONAUTS DISCUSS CONTROL FAILURE. Russian spacemen Pavel Belyayev and Aleksei Leonov admitted that a control failure in their vehicle required them to land manually, and that they overshot the landing area.

LINSEED OIL FOR THE HEART. Diets containing unsaturated vegetable oils have long been thought to have an influence in reducing heart attacks. Now a Norwegian researcher says only those oils containing linolenic acid (soybean and linseed oil) seem to have any marked effect. Dr. Paul A. Owen of Oslo is now conducting a test on over 10,000 Norwegian men between the ages of 50 and 59. During the two years of the test, the men will be given a daily tablespoon of linolenic acid. Dr. Owen warned that so far no definite conclusions have been reached, adding, "It is premature at present to recommend such dietary changes for the population at large."

A VERY HUMAN HAMSTER. A breed of laboratory animal that gets congestive heart failure, one of the commonest circulation disorders in man, has been found. This discovery will offer new opportunities for studying the nature of congestive heart failure and related problems, and the effects of drugs, diet, exercise and rest. The all too human animal is the Syrian golden hamster.

TRANQUILIZER CHANGES EYES. The most widely used tranquilizers in U. S. mental institutions may be responsible for opacities of the lens and cornea of the eye. Many patients developed minute yellowish or whitish specks after taking phenothiazine derivatives. But physicians who reported finding the changes stated, "No visual impairment was detected among the patients with the ocular opacities, even the most marked opacities....We have no indication that visual impairment is to be expected."

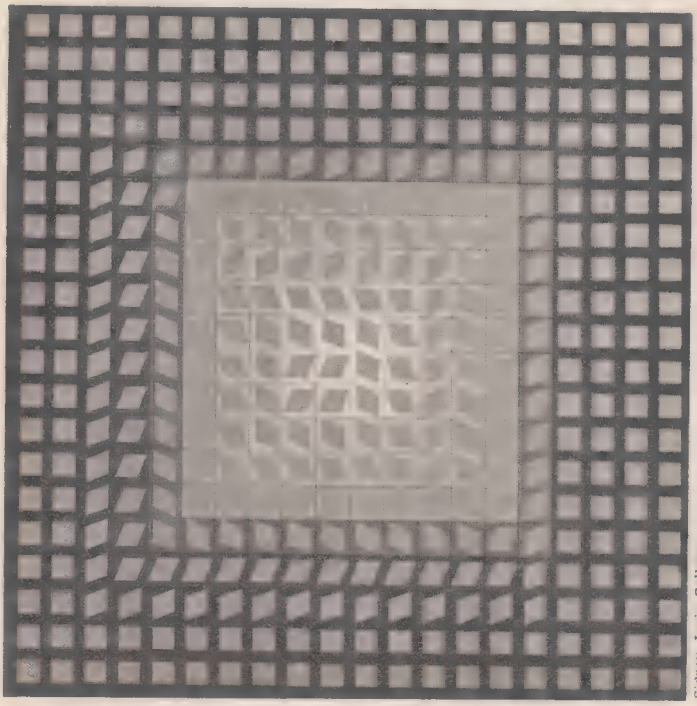
TONSILS MAY BE USEFUL. Human tonsils, once regarded as useless, may have important functions in developing the individual's immune defense system, said Dr. Robert A. Good of the University of Minnesota. Twenty years ago tonsils were almost always removed. Enthusiasm for tonsillectomies has declined in recent years. Now Dr. Good suggests that tonsils should never be removed unless tonsil tissue is involved in a severe disease problem such as cancer.

EARLY GLAUCOMA TEST. A way of detecting glaucoma susceptibility years before the blinding eye disorder strikes has been developed by Dr. Mansour F. Armaly of the University of Iowa. Glaucoma blindness can easily be prevented by surgery and drugs if the disease is recognized early enough.

'SAFE' PESTICIDE. A pesticide that will kill houseflies and certain other insect pests but will not harm warm-blooded animals has been developed by a team of industrial chemists from the Shell Development Co. and Stanford Research Institute. The chemical, which is still in the experimental stage, is a new member of the class of insecticides called organophosphates.

QUOTE OF THE MONTH: "Even the Communist party must accept the fact that its supervisory powers in the natural sciences are relatively limited, for no modern state can afford to dictate the content of theories in the natural sciences without risking technological suicide." David Dinsmore Comey of Cornell University, an authority on Soviet cybernetics.

The science of Op Art



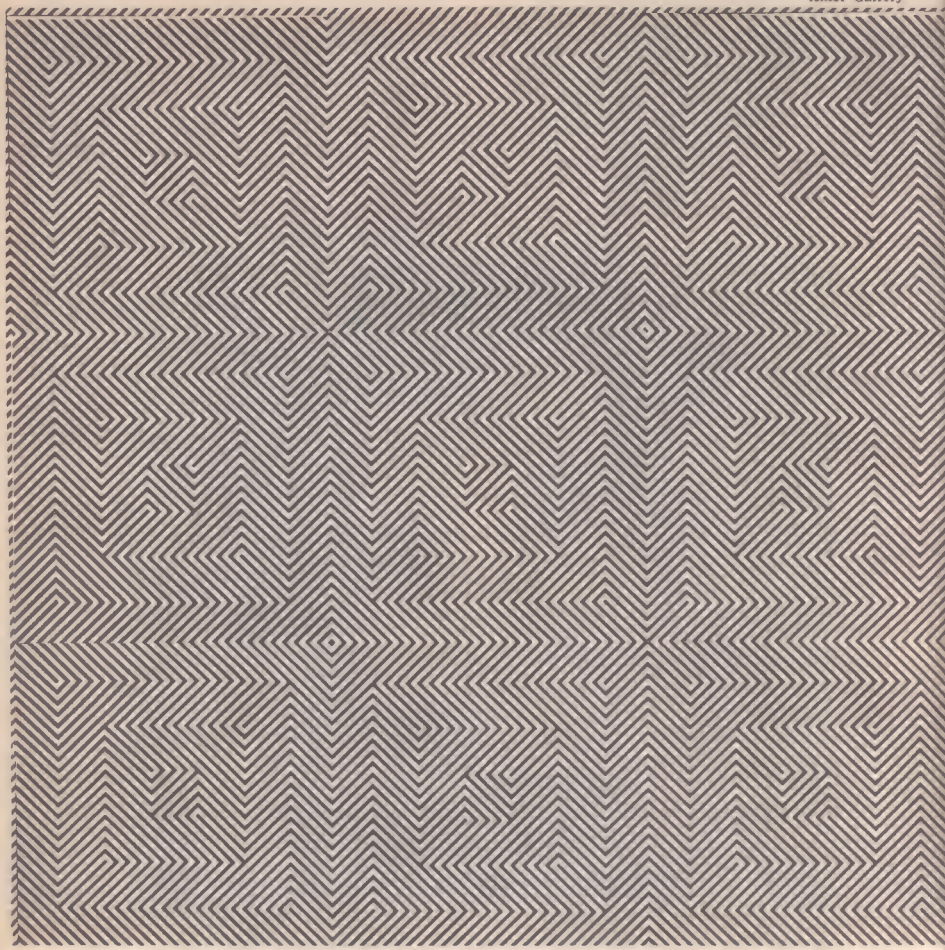
Sidney Janis Gallery

SURKE, by Victor Vasarely, has the look of translucent, frosted glass.

by Bruce H. Frisch

THE paintings jumped and quivered and spun and undulated, sending visitors to New York's Museum of Modern Art reeling out of the *Responsive Eye* show feeling it should be labelled the *Battered Eye*. With the prestige of a Museum of Modern Art show behind it, op (for optical) art officially joined pop art (blown up comic strips and soup cans) as successors to abstract expressionism in the *avant garde*.

To the non-scientist, op art is based on optical illusions, but psychologists have learned to call them optical surprises. The surprises are genuine perceptions whose implications don't stand up under test. They have been easier to describe than explain. It is only recently that involuntary eye movements and after-image, upon which so much op art depends, have been



SQUARE OF THREE: BLACK AND YELLOW, by Reginald Neal uses after-images.

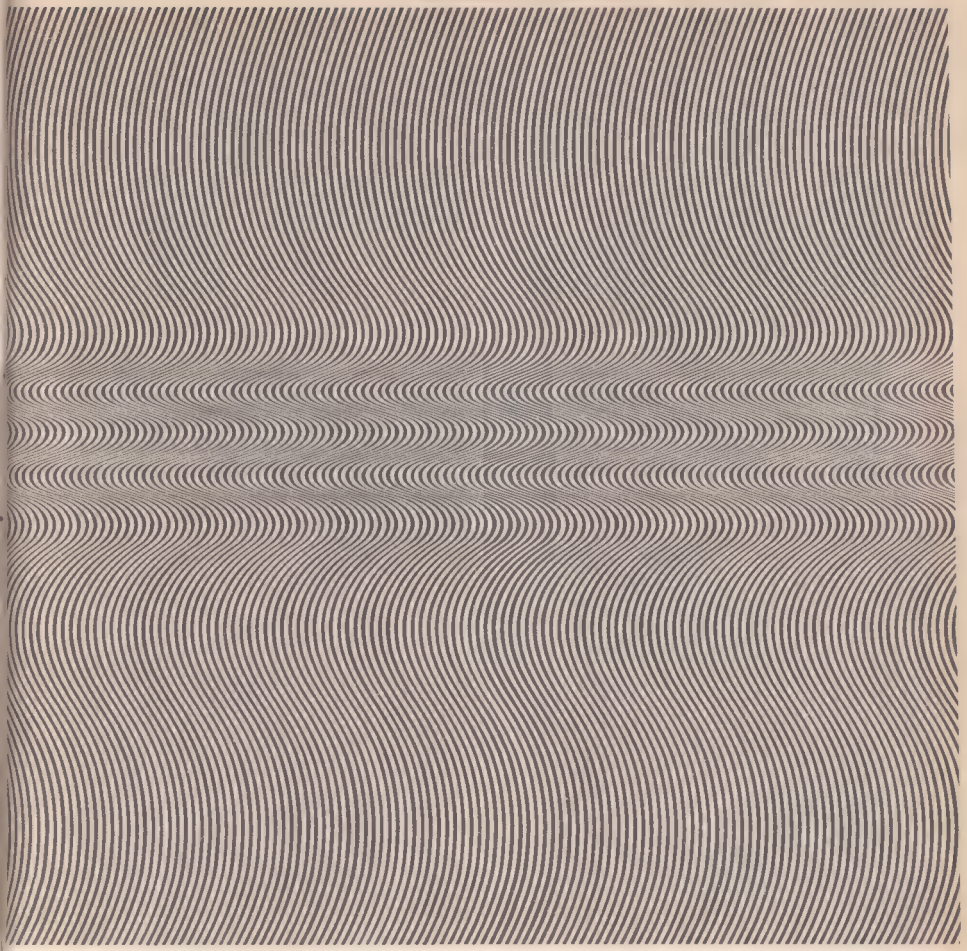
successfully tested and understood.

To analyze eye movements, biologists and electrical engineers at the California Institute of Technology worked together to attach a tiny mirror to a contact lens. As the eye of the person wearing the lens moved, a spot of light that was bounced off the mirror moved in greatly exaggerated sweeps which were recorded on photographic film or by a photomultiplier tube. When the eye was fixed on a point, it wandered slightly off center, by slow, steady drift and much farther off center by swift, step-wise flicks.

This was not just nervousness. If the eye remains perfectly fixed on a still object, the image on the retina will quickly fade away. A picture has to be constantly shifted to keep an image alive.

When a person examines a picture, his eye jumps from spot to

The Museum of Modern Art, New York. Philip C. Johnson Fund.



Overlapping image and after-image combine patterns in CURRENT, by Bridget Riley.

spot, picking at facts rather than sweeping across the picture absorbing information from a broad swath. At each jump, a small area of the picture is focused on the fovea, a dimple on the back of the eyeball where light receptors are close-packed for detailed seeing. A thumbnail viewed at arm's length would just about cover the area seen by the fovea.

Jumpwise eye movements also enable us to judge the shapes of contours and lines. As the eye jumps along a straight line, the successive images fall on the same row of receptors, but if it jumps across a step in the line, different sets of receptors are stimulated.

Ordinarily, an after-image remains impressed on the retina for a few seconds, although it can persist for hours or a week in special circumstances. Because of the jump-

wise movements of the eye, successive after-images leave a series of distinct, sharp pictures. If the eye made sweeping movements, a blur would be left behind, and the picture on our cover would not seem to spin.

Look at the center of the pattern on the cover and watch the spokes turn. Image and after-image are superimposed—slightly out of register. We see the intersections of the overlapping circles as radials. Our sense organs and nervous system "tend to organize or modify our perceptions into simple patterns or objects. . . . Even when we try very hard, it is difficult to overcome such organizing tendencies in perception," writes Charles W. Eriksen of the U. of Illinois.

It is more common for the artist to provide a real overlying pattern. Or, if a pattern is drawn on glass or transparent plastic and held away from a surface, the pattern and its shadow will combine to form the third pattern, which is called a moiré.

"The only general requirement for a moiré pattern is that the interacting figures have some sort of open and solid regions," say Gerald Oster, professor of polymer chemistry at the Polytechnic Institute of Brooklyn, and Yasunori Nishijima, lecturer in polymer chemistry at Kyoto U. They have found many scientific uses for moiré patterns, especially for arriving at visual solutions to problems that would be extremely difficult to solve mathematically.

Oster has branched out into art, and this past winter, he exhibited roomfuls of variations on the moiré idea. A common trick was to leave an inch or more's gap between overlying patterns so that, as the observer moved, the moiré shifted and shimmered.

Other op art practitioners use different techniques.

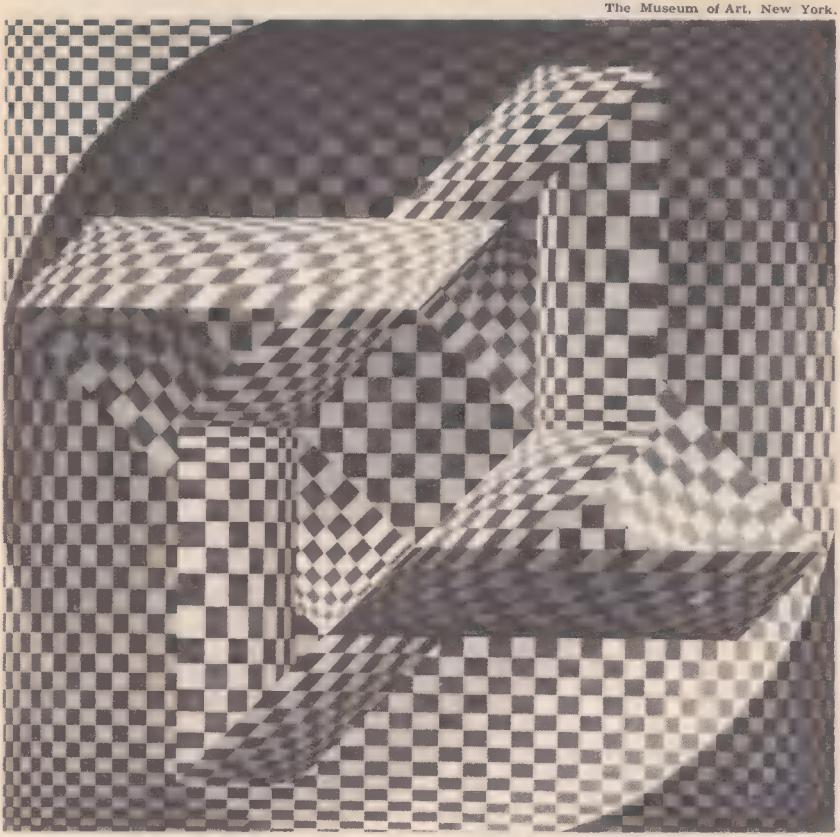
The artist John Goodyear hangs a set of wooden bars in front of a painted pattern. As the bars swing, the moiré moves.

Other artists manipulate color to create motion. The border between carefully calculated colors seems to jump from side to side; spots of color seem to float across the canvas, or develop pulsating coronas—all as a result of *negative* after-image.

Fix your eyes on a city skyline, for instance, then look at a white surface. You will see an after-image in which dark is light and light is dark. The color will be reversed too. Each original color will appear as its complement, the color that added to it would produce white.

Within the last three years, experimenters have learned why this happens. The eye sees color with three different light-sensitive receptors having peak sensitivities, respectively, for deep blue-violet, green and yellow. Each kind of receptor contains molecules of a different light-sensitive pigment. Light breaks the molecules in two, starting an electrochemical impulse on the way to the brain. One of the two pieces is a substance that inhib-

The Museum of Art, New York.



A baby is old enough to sense the depth illusion of Ben Cunningham's EQUIVOCATION.

its the breakdown of their pigment molecules. Wherever the substance remains, the retina will be less sensitive to light. Thus, light projected on the retina leaves behind a duplicate pattern of inhibiting chemical. When the retina is then illuminated uniformly by looking at a white surface, all the receptors are stimulated except where the chemical is.

White light contains all the visible colors, but inhibited receptors will respond only to those not present in the previous image. Where there was red, you will see green; where there was blue, you will see yellow.

A Larry Poons painting, for instance, has green spots scattered over a red field. You will also see light red spots—after-image colors tend to be bleached. Concentrate on one spot and it will grow a fuzzy red edge as the eye shifts slightly.

To stimulate these effects, the colors of the painting have to be precisely matched complements which printed reproductions rarely duplicate.

For the art world, op art is another step in the trend toward kinetic art. For the general public, it's another idea in fashion design.

Movement is one side of op art; depth is another. Where artists paint simulated light and shadow to suggest depth, they take advantage of our learned habit of thinking that light comes from above. We know it is learned, because chickens have been trained by artificial illumination to think that light natually comes from below. If we see a relief map lit from below, we unconsciously reverse the contours, turning valleys into ridges and mountains into craters in order to make the lighting appear right.

In his *Equivocation,* Ben Cunningham plays upon depth cues that infants have learned by the time they can crawl and chicks recognize within 24 hours after birth. These, size of the squares and density of the pattern, may fool you into seeing a three-dimensional surface while you are standing still, but move your head and the illusion dissolves, because motion parallax is missing. We know innately that the nearer surface should move more than the farther.

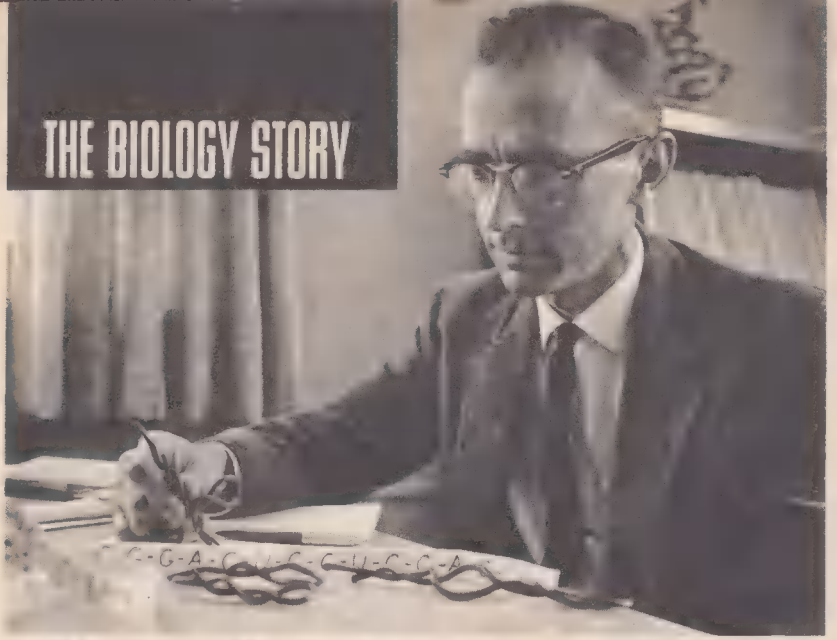
With no color and little form, Victor Vasarely, Hungarian-born Frenchman who has been plugging away at op art for 20 years, has created a surprise by the sophisticated use of shades of gray. In the original, his *Surke* appears to be a grid over frosted glass behind which is a light.

Psychologists at Swarthmore College found that we judge the darkness and lightness of colors by comparison with adjacent areas rather than by the absolute measure of the light they reflect. In the laboratory, a disk was projected inside a larger ring against a black background. If the ratio of illumination between the disk and ring remained the same, they appeared to stay the same shades regardless of the lighting level. The larger area, the ring, appeared luminous or translucent whatever the ratio, while the smaller area, the disk, appeared opaque under most conditions. At four times the lighting intensity of the disk, the ring appeared white as well as luminous.

Surke's grid looks opaque. The larger squares look translucent even at the edges of the painting, where they are darker than the grid.

What does it all mean? In the art world, some authorities see the depth and movement illusion in op art as another step in the twentieth-century trend toward real movement in real space—the so-far unrealized kinetic art.

For the general public, op art has already resulted in a whole host of new fabric designs for this year's clothes, including bathing suits—that plus a new appreciation for the tricks their eyes can play on them.



Prof. Robert W. Holly of Cornell examines a strip of tape representing alanine transfer RNA. Letters on the tape stand for the 77 parts (nucleotides) making up the RNA molecule. Twisted wires on the desk represent possible configurations of the molecule.

Nearer the secret of life

For the first time in history, man has determined the structure of a nucleic acid, a carrier of hereditary messages.

This scientific breakthrough, the full consequences of which will take years to realize, was accomplished at Cornell University by a team of scientists headed by biochemist Robert W. Holley.

The type of nucleic acid studied by the researchers is a ribo-nucleic acid more commonly called RNA. The particular RNA investigated is known as alanine transfer RNA. Transfer RNAs are the smallest biologically active nucleic acids known. Since this is the first one for which the complete sequence of parts has been revealed, the breakthrough opens the way for determining the structure of others.

What the researchers actually did was to determine the sequence of parts (nucleotides) that make up the alanine transfer RNA. These parts might be described as "boxcars" linked together to form a train of 77 "cars." The major problem was to find the order in which the different kinds of "cars" were coupled.

In simplified terms, the laboratory work included use of an enzyme that broke the couplings between certain "cars," leaving individual "cars" and short strips of "cars." This was followed by use of another substance that uncoupled other "cars." After each uncoupling

experiment, including a final one which broke the "train" in half, the fragments were analyzed. By comparing one set of breakdowns against another, and so on, the researchers eventually were able to piece together the entire "train."

Messages "written" in nucleic acids give instructions for the formation of protein and other constituents of which man and other forms of life are basically made. They actually determine how an individual will be fashioned out of his intake of food. They do this in terms of instructions from the former generation.

Messenger

The specific job of the RNA is to carry and transfer messages that were given to an individual at the time of conception in the form of nucleic acids called DNA (deoxyribonucleic acid). Throughout the life of an individual, RNAs are at work copying DNA messages and carrying them to the point where needed protein is "constructed" out of other protein that was eaten.

Dr. Holly says of his work, "We must know the structure of nucleic acids before we can fully understand their functions."

Scientists point out that such knowledge might eventually lead to controls over the formation of life itself, since DNA holds the specifications for an individual and RNAs start transferring these specifications from the moment an embryo begins to develop.

Greater understanding of the DNA-RNA complex may lead to new controls over disease and genetic defects. The building of cancer cells, for example, results from some sort of scrambling in the messages. Since viruses contain DNA and RNA, knowledge of these nucleic acids is valuable in the fight against virus diseases.

Like our ancestors

Man and other animals and plants are shaped into the images of their ancestors through these genetic messages carried by DNA and transferred to RNA. A mixup in the code, therefore, results in a mix-up in formation.

When man eats protein in the form of beef, for example, that protein is converted to flesh, skin, hair, muscle, or whatever protein his cells need at that time.

The RNA messages "tell" the 20 amino acids, which make up proteins, how to arrange themselves. This order of arrangement determines the kind of protein. Transfer RNAs actually translate information from messenger RNAs into the amino acid sequence (protein). The messenger RNAs get their information from the DNA.

The particular RNA studied by Holly and his co-workers is one of three transfer RNAs which they isolated in pure form for the first time in 1962. Three years of work led to the 1962 development, which in turn led to the current achievement.

How to grow tall

by Arthur J. Snider

On entering Yale University, the class of 1967 averaged 5 feet, 10 inches, 160 pounds and 18 years.

They were an inch taller, 12 pounds heavier and two months younger than those in the class of 1938, which is contemporary with their fathers.

This comes as no surprise to bedding manufacturers, clothing retailers and parents who comment with delight or dismay that their sons or daughters are towering over them.

It has not been a sudden phenomenon. Recruits in World War II averaged 68.15 inches, or about two-thirds of an inch taller than the boys of World War I. Twenty-seven percent of those in World War II were 5 feet 10 or more, compared with 22 percent of those in World War I.

Over a 75-year period, Harvard students showed an average gain of about a centimeter every 12 years, or a total of more than 2¼ inches.

Today, the average height of Americans is at an all-time high and is coming close to 5 feet 9 inches at the 20 to 29 year age level.

How long will the gains continue? Are we headed for story-book giantism? Geneticist Amram Scheinfeld, in a new book, dismisses any such possibility.

"Some authorities believe that at best, the average height for American males might reach 6 feet in 200 years," he writes in "Your Heredity and Environment." "But a restraining fact is that if human stature goes too far, it may be at the expense of fitness."

He noted that a few human giants have attained heights of eight feet or over but all have succumbed in their 20's or early 30's.

There is some evidence that average height may not go much higher and may even be leveling off.

Dr. Harry Bakwin, New York pediatrics professor, cites figures showing that maximum potential height may have been reached two decades ago among the upper socio-economic groups in the United States.

Whereas Harvard entrants from public schools increased about 1.7 inches during the last 25 years, the height of entrants from a selected group of private schools remained unchanged.

At present, the height of entrants from public and private schools is the same, indicating that public school entrants to Harvard have

also attained the outside limits of growth permitted by heredity.

Dr. Bakwin believes the developments can be accounted for by the good nutritional diet of the upper class all through the years and the advances of nutrition in more recent years that have permitted the middle class to catch up.

Dr. I. Pat Bronstein, professor of medicine, University of Illinois, agrees that nutrition is one of the most significant factors accounting for the growing stature of American people.

But he also notes that elimination of many childhood illnesses, each of them capable of retarding growth to some degree, has also contributed.

Dr. Stanley M. Garn, chairman of the department of growth and genetics, Antioch College, also supported the role of medicine and said those areas of the world that have still to benefit from health and nutritional factors can still expect increased growth by their people.

But in the United States, it is likely that the better-fed may already have reached their limit, Dr. Garn said. In fact, there could be a slight decline ahead.

He points out the growing concern of the perils of too much weight. Since adding to height usually is accompanied by increasing weight, it is conceivable that lowering the calorie consumption in the interest of retarding obesity may at the same time drop the height average fractionally.

Science has no pill to influence height. The closest thing to it is HGH, the human growth hormone. Since HGH must be obtained at autopsy from the pituitary glands of human beings (animal pituitaries cannot be used), the substance is as rare as precious gems. It is not obtainable commercially. The government controls the limited supply and apportions it to institutions for research purposes.

HGH helps youngsters whose understature is due to a deficiency of pituitary. Some remarkable growth gains have been achieved but there have been failures, too.

Even if the supply were plentiful, only a fraction of one percent of youth could be helped because this cause of under-stature is rare.

The vast majority of short children can attribute their size to heredity. They have inherited their parents' genes for shortness.

Another large group of short youngsters simply mature slowly. These youngsters will eventually catch up, but are so distressed by their size, they cannot wait.

Physicians frequently speed up their growth rate by giving them sex hormones, although not all doctors favor the procedure. While the hormones speed growth, they sometimes shorten the growth period by causing premature closure of the growing centers in the long bones. Dr. Bronstein contends premature closure need not happen if the hormones are given intermittently.

Hormonal treatment also can help bring a quick end to the growth of boys and girls who are excessively tall.

Heart attacks we deny

There is frequently a tendency to explain away the pain of a coronary heart attack by attributing it to other conditions less threatening to life.

Dr. Harry S. Olin of Massachusetts General Hospital and Dr. Thomas P. Hackett of Harvard Medical School studied 32 patients soon after they were hospitalized for a heart attack. Thirty said they felt initial pain in the chest while two experienced it first in both arms. All said it was the most uncomfortable experience they had ever endured.

Among the descriptions given were: "It was as if someone was standing on my chest," "Like a red hot poker passing through me," "As if a hole were being torn in my chest," "My chest felt like it was on fire."

Despite the pain, the common response was to delay seeking medical help. Eleven patients took five or more hours to decide to see a doctor while the remaining 21 decided within five hours. It was only increasing incapacitation or the persuasion of relatives and friends that finally led them to a doctor.

Each of the 32 diagnosed his own symptom early in the course of the illness. Fourteen explained their pain as indigestion, seven felt they were coming down with a lung disease. One thought she was having a flareup of a duodenal ulcer. Only 10 correctly diagnosed their conditions as heart attacks.

Practically all 32 patients knew people who had sustained heart attacks. They were familiar with the relationship between severe chest pain and heart disease. But this knowledge seemed to be of little value in the management of their own symptoms.

A 42-year-old cab driver, for example, had seen his father die of an acute heart attack. But when he was awakened from sleep by symptoms resembling his father's, he waited until morning to ask for help. During the wait, he rationalized that the pain could not be heart trouble because, as he put it, "If it was a clot in my heart, I would die."

The doctors point out that young children commonly react to a threatening situation by denying that danger exists. In adults, the pain of a coronary attack is too severe and enduring to be dismissed. It must be accounted for, but in a non-

threatening way, such as by displacing the site. If the source of pain is thought to be the stomach rather than the heart, it becomes a more benign discomfort.

After enduring severe pain for a considerable period and after exhausting all available home remedies, the patient's ability to deny the seriousness of his condition tends to diminish. He then turns to flimsy, transparent excuses, such as not wanting to inconvenience the doctor. Generally, when this stage is reached, a friend or relative takes action to obtain help.

On the basis of their study, the two physicians wonder how many patients die simply because they have no one available to correct the flaw, created by denial.

Condemned before birth

For 84 percent of the legally blind children in this country, blindness begins before they're one year old. A study by the National Society for the Prevention of Blindness shows that 71 percent of blindness in school children is due to prenatal influences and 29 percent to other causes, Dr. Kenneth L. Roper of Northwestern University reports in *Clinical Pediatrics*.

Two infectious diseases account for four percent of blindness. One is German measles. If occurring in the first three months of pregnancy, a congenital cataract may be produced in the infant. The other is toxoplasmosis. It produces only mild symptoms in the mother, being frequently regarded as an insignificant "cold." But in the fetus it often causes extensive scarring of the retina that destroys useful vision.

Tumors are responsible for 3.5 percent of blindness; injuries, 2.4 percent.

Retrolental fibroplasia, a destruction of the retina resulting from too much oxygen being given to premature infants, is now the second leading cause of blindness. New cases have all but disappeared, now that doctors are measuring accurately the oxygen concentrations to which prematures are subjected. But the full impact of the disease is still being felt, for it gave rise to an estimated 8,000 blind or partially sighted victims now attending schools for the blind.

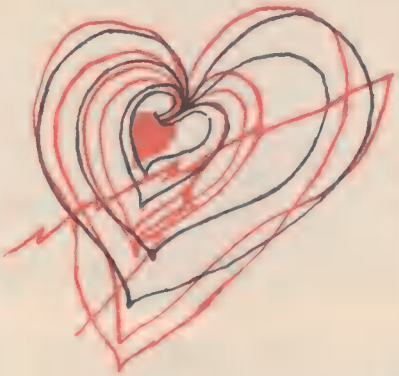
Non-congenital cataract is responsible for almost 12 percent of blindness. The results of surgery are far inferior to those of cataract surgery in the adult. The perfect operative result of 20/20 vision is rarely obtained.

Defects in the optic nerve account for nearly 10 percent of blindness. Doctors are constantly asked to examine children who do not appear to see. When no ocular defect is discoverable, by far the most common cause of the apparent blindness is mental subnormality. These children will be retarded in all aspects of development.

The rate of blindness due to injuries has shown a downward trend since 1937-38.

Pacemakers—plus and minus

Cardiac pacemakers, about the size of a small transistor radio, have helped keep several hundred persons alive since their implantation about three years ago, but they have a tendency to break down in use, according to Dr. Simon Dack of the department of medicine, Mt. Sinai Hospital.



Pacemakers are designed to deliver a mild shock to the heart 60 to 80 times a minute, replacing the normal nerve impulses to the heart which have been blocked by disease.

Occasionally there is a mechanical or electrical failure of the instrument after it has been implanted in the body cavity and of its electrodes implanted in the heart muscle. Yet the pacemakers' advantages far outweigh their disadvantages, in Dr. Dack's belief.

Should a breakdown occur, there is usually enough time to admit the patient to a hospital and correct the failure.

The earliest pacemakers were worn outside the body and connected to the heart by wires passing through the chest wall. With the development of miniaturization, the internal implantation was possible, thus reducing the risk of infection.

Even poor risk patients can undergo the surgery necessary to place the device in position. In a series of 54 cases reviewed by Dr. Dack, only one was an operative mortality. The age range included patients in their 70's and 80's.

New burn treatment

For many years, silver nitrate was applied to the eyes of newborn babies to kill germs that might promote blindness. With the introduction of antibiotics, silver nitrate was largely supplanted.

Now Dr. Carl A. Moyer, professor of surgery at Washington University School of Medicine, St. Louis, has revived silver nitrate as a treatment for burns.

Dressings soaked in a solution of silver nitrate appear to provide a barrier against the entrance of germs. They also serve to reduce seepage of body fluids from the burned areas. Dr. Moyer finds the therapy has virtually eliminated the problem of staphylococcus infection, often encountered in burn victims.

Under conventional therapeutic approaches to burns, half the people who have 50 percent or more of their skin burned away will die.

THE SPACE PICTURE

Looking down on the earth...

ASTRONAUT John Young, co-pilot on the recent first manned Gemini shot, snapped this picture (left) while orbiting 90 miles above the earth on March 23. He took the photo during the second orbit, while the spacecraft "Molly Brown" passed over Mexico. The California-Mexico border runs through the center of the photo. The large clear area to the right of the nose of the spacecraft is the Sonoran Desert. At the top center of the photo, covered by some clouds is the Imperial Valley of California.

...the moon

The day after Young took his pictures of the earth, the automatic television cameras aboard the Ranger IX spacecraft recorded this photo (left) when 115 miles above the moon. This was just 1 minute 17 seconds before the craft impacted on the floor of the crater Alphonsus. The photo shows the crater floor cut by prominent rills which are lined with dark halo-type craters that have covered part of the rill, features never visible to earthbound telescopes. Astronomers found that the floor of the crater did not look very different from the mares (lunar planes) photographed by the two previous successful Ranger shots and televised back to earth.

Are You A 3rd-Grade Reader?

A noted publisher in Chicago reports there is a simple technique of rapid reading which should enable you to double your reading speed by this s i m p l e, proven m e t h o d and yet retain much more. Most people do not realize how much they could increase their pleasure, success and income through r e a d i n g faster, easier, more accurately. The details of this method are described in a new book, "Adventures in Reading Improvement" sent free on request.

According to this publisher, anyone, regardless of his present reading habits and reading speed, can use this simple technique to improve his reading ability and develop it to a remarkable degree. Whether r e a d i n g stories, textbooks, technical matter, it becomes possible to read sentences at a glance and entire pages in seconds by following this method.

To acquaint the readers of this publication with the easy-to-follow rules for developing rapid reading skill, the company has printed full details of their interesting self-training method in a new book, "Adventures in Reading Improvement" which will be mailed free to anyone who requests it. No obligation.

Simply send your request to: Reading Improvement Program, 835 Diversey P a r k w a y, Dept. C78A, Chicago, Illinois 60614. A postcard will do.

WONDER OF THE MONTH

Elevator rat

To test the subtle processes of learning, psychologists use many kinds of ingenious devices on their laboratory animals.

The pictures at right show a rat operating a Rube Goldberg device that finally gave him some food. The project was developed by Charles Holzer III, a student at Haverford College, Haverford, Pennsylvania, for a psychology laboratory course.

First the rat goes to the elevator (1) and pulls it to the top (2). Then he goes to the stairs and descends into the original cage (3). Next, he pulls the chain (4), which turns on the light, which tells him he can push the lever and be fed (5).

The little rat learned to do all of this in a backward manner. He first learned to push the lever to get fed, then to push the lever only when the light was on, and then to turn the light on by pulling the chain. Each time, he went all the way through to the point where he was fed. This reinforced the entire chain of behavior.

The series of actions could be extended almost indefinitely.

Says Holzer:

"Although you didn't learn to run an elevator this way, you must admit that there are striking similarities."

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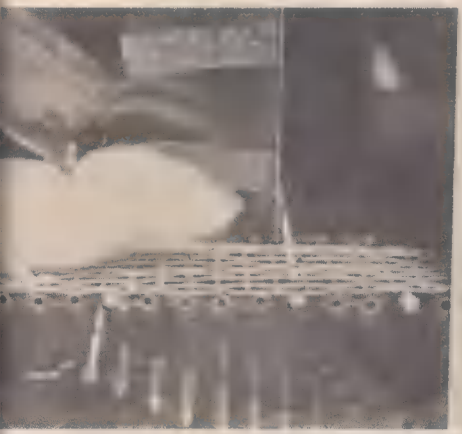

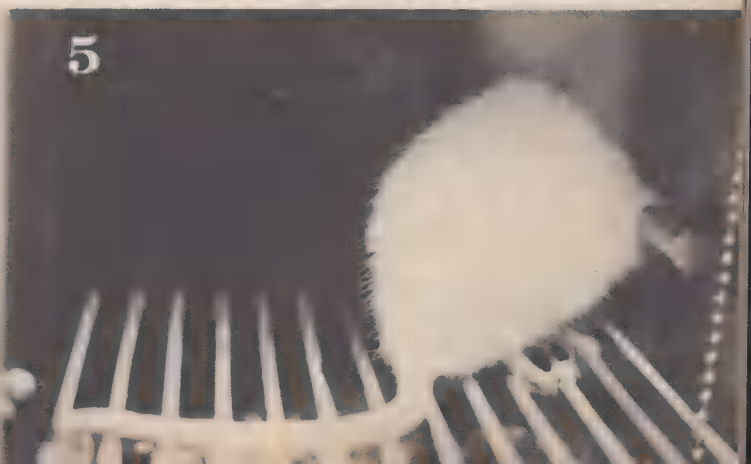
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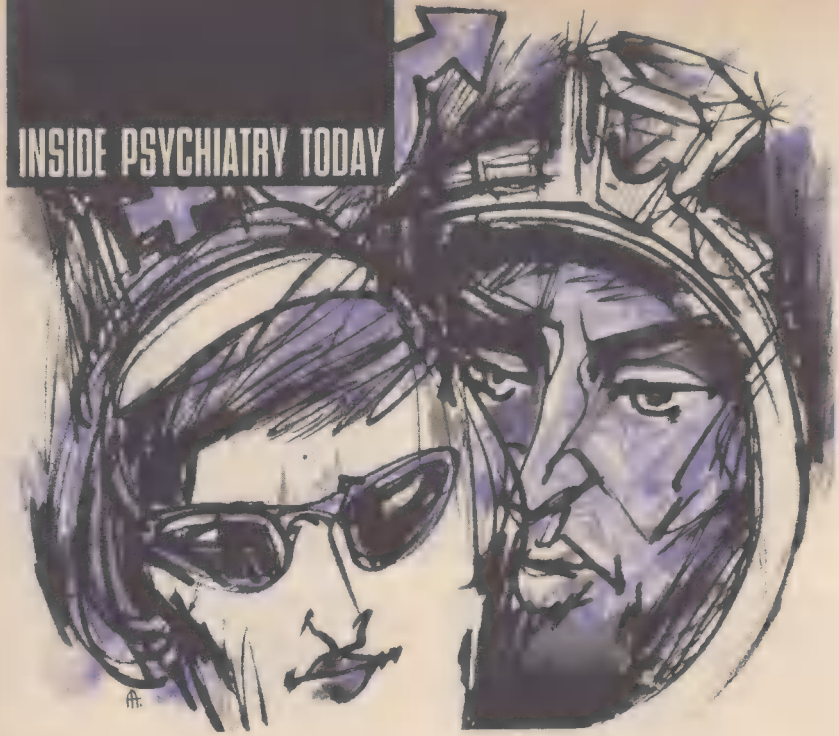
INSIDE PSYCHIATRY TODAY



Marriage— neurotic and otherwise

by Flora Rheta Schreiber and Melvin Herman

MARRIAGES may not be made in Heaven, but there's nothing accidental about them. The psychological reasons for good or bad marital choices, for happy marriages or divorce, are all discernible.

The Society of Medical Analysts recently held "A Psychoanalytic Symposium on Marriage" to chart the course of American marriage. Although marriage was called the most unstable of all possible social relationships by one speaker, the consensus was that Americans hold married life to be the normal and much-to-be-desired state for all adults.

Americans are the most marrying people in the Western World. Ninety-two percent of us marry, according to Dr. Simon Nagler, Associate Clinical Professor of Psychiatry, New York Medical College. There are, moreover, more early marriages in the United States than anywhere else in the West. One-sixth of all American girls between fifteen and nineteen are married. Since 1890, says Dr. Nagler, we have been marrying at a continuously increasing rate.

This upsurge does not mean we have a greater capacity for love. For love and marriage do not always go together like a horse and carriage. Men and women are frequently drawn to each other because of interlocking neuroses. They may stay married for neurotic needs.

"Marriage is an opportunity to act out one's despair, hatred and vengeance on someone who may be dependent on you in many ways," says Dr. Leon Salzman, Associate Professor of Clinical Psychiatry, Georgetown University School of Medicine. "In this way, marriage is very much like psychoanalysis itself, in the absence of restraint and inhibition and in the ability to behave without fear of criticism or reprisals."

Whom do we marry? The lucky individual who functions at a mature level picks a mate who functions as well as he does. Choices of a mate generally are limited to persons with an equal sense of identity and maturity, the same sort of strengths and weaknesses. An immature person selects an immature mate. A partner in such a marriage often is faced with the goal of preventing the other person from obtaining a superior position, while at the same time avoiding responsibility for decisions.

Merely staying married is by no means an indication of the success of a marriage. Psychiatrists often are impressed by the degree to which a marriage is held together by mutual resentment and aggression, to the exclusion of love or any semblance of affection. The partners spend an unbelievable amount of energy in devising ingenious and devious ways of torturing each other. Such couples stubbornly keep together, usually resisting separation or divorce even when the dissolution of the marriage is the only means of solving otherwise insoluble problems.

Playing house

Many couples aren't genuinely married; they are only playing house. They might have married in the first place because they both wanted a home. If they become estranged for one reason or another, the home for which they married loses all meaning.

Dr. Sandor Lorand, Clinical Professor of Psychiatry and Chairman of Advanced Studies, State University of New York, told of a couple who had come together through their mutual interest in the same field of work, a scientific one. After their marriage, they found to their dismay that no common meeting ground really existed. Having little to say to each other, they spent days and nights away from home, going to meetings and lectures separately. They no longer enjoyed even the friends they had in common and their social life shrank.

When the wife turned to therapy, she discovered that many of her problems had originated in her early home life. All the members of her family, in which she was the only girl, were highly ambitious.

Male-female relationships are complicated for some types of persons by their intense fear of being disappointed in all human relationships.

When she married, she chose a man without much ambition, the very antithesis of her father and brothers. She wasn't fully committed to marriage, and just played at it.

Her husband also had difficulties he had carried over from his childhood. He always had been excessively close to his mother and now found himself incapable of mature love for his wife. His heart belonged to Mom. His wife was just a substitute for her.

Many marriages suffer from a residue of lingering childhood conflicts. "Our early development makes us bad wives or husbands," said Dr. John A. P. Millet, Professor of Psychiatry and Assistant Dean, New York School of Psychiatry. Again and again, Dr. Millet observed, psychiatrists see the narcissistic requirements of the infant and developing child reflected in the behavior of married adults. There is, for instance, the spoiled darling who always expects to have his or her own way. There also is the man or woman whose narcissistic requirements were not adequately recognized or sufficiently gratified in infancy and childhood. These persons may develop into tiresome, self-apologetic bores or experts in making half-apologetic demands.

Many marriages also exhibit an overwhelming dependency need, which is a hangover from having been improperly handled during the developmental years. This impulse toward dependency all too often is the principal reason for getting married in the first place and is the source of competitive drives for attention and the mainspring of disappointment with marriage. Unresolved dependency results in depressive reactions, problem drinking, gambling, extravagance, and in nagging wives and hypercritical husbands.

The root of many divorces

Other marriages totter because of sexual disappointment. "Certainly this lies at the root of a great many divorces," stated Dr. Millet. "It is true, however, that many of these marriages began with what both partners seem to think, in retrospect, was a very satisfactory experience so far as sexual compatibility was concerned." The sexual relationship loses its bloom, apparently, as other aspects of the marriage deteriorate.

Marriages in which husband and wife are emotionally immature, are generally doomed to failure. One partner or the other may deny his

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Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

feelings of inadequacy and play-act at adequate functioning. This leads the mate to abandon attempts to function adequately and to become irresponsible and dependent on the psuedo-well-functioning partner. In some of these marriages, each spouse alternates between overadequate and underadequate roles.

There are marriages that move inevitably toward dissolution because they are inherently what Dr. Sandor Lorand calls "serial marriages." Typically, the husband or wife suffers from the compulsion to change mates. Yet, at the same time, these men and women cannot be alone. The time between marriages is one of intense loneliness. Simply coming home to an empty house at the end of a busy day terrifies them. Often these persons function successfully in work that keeps them in constant contact with people. But at the day's end, the fear of loneliness, which has been dissipated somewhat during the day, returns in full force. They find the prospect of being alone in bed, facing a dark room alone, a torment. Ridden with an unconscious, insatiable need for love, they have a need to belong, a desire for a dependent relationship with a loving person who, invaribly, represents primarily the mother and secondly, the father. As analytic patients, they reveal that they have carried within them the seeds of unresolved early childhood struggles which prevent the achievement of the love they crave.

Their search for a father or mother is an ironic one. In childhood, they were failed by parents who denied them love and affection. As adults, they continue the search begun in childhood for the good parents they never had. When they marry or even become involved with the opposite sex, they seek not mates but parents. Male-female relationships are further complicated for such persons by their intense fear of being disappointed in all human relationships. Gratification in marriage thus becomes unattainable.

The "bachelor husband"

Special personality problems of either husband or wife also jeopardize a marriage. The so-called "bachelor husband," for instance, wants the best of single freedom and married belongingness. The result is that he takes flight from marital responsibilities, preferring to spend his time with the boys at club meetings, card games, and sporting events, to being with his wife.

Perhaps the most paradoxical marriage was previously described in a paper by Dr. C. Eugene Watermann as "family togetherness without closeness." Such a marriage is organized around the neurotic symptoms of either the husband or the wife. The relationship becomes one of curious accommodation, whereby one completely adapts his life to the other. This accommodating behavior becomes an integral part of the conformer's personality. By focusing on his partner's symptoms, he submerges his own problems and

emotions and encourages childish behavior in the other by treating his partner as a child.

Such a couple lives in a sort of armed truce. Yet, the very emotional distance between them serves as protective armor against the fear of acting alone. One husband of this type admitted to Dr. Watermann that he felt unworthy of his wife's love. In joint therapy, both the husband and wife referred to the wall between them. However, the wife broke through the wall when she spoke of feeling angry and unloved when her husband didn't touch her. When encouraged to describe inner thoughts and feelings, the wife confessed, "My main goal is to keep peace."

Good marriages

In good marriages, husbands and wives often see things differently and need not compensate for the partner's inadequacy. They may function in different ways but the levels of functioning are equally adequate. Trouble comes when reactions are unsatisfactory. For instance, there is the marriage in which both partners are unsure of themselves in the presence of authority figures, but one reacts with rebellion and the other with overcompliance. Both may be unsure with strangers. One, however, may withdraw into silence, while the other bursts into incessant chatter. A situation that stirs anxiety in both may find one responding with frenzied emotion and impulsive behavior while the other exhibits extreme inactivity and over-emphasized intellectual concern. Also when both are uncertain as to what to do, one may become rigidly dogmatic while the other grows passive and helpless.

Yet, as Dr. Salzman pointed out, marriage can reduce the possibilities of neurotic development, despite the persistent pressure of another and the responsibilities aggravated by the presence of children.

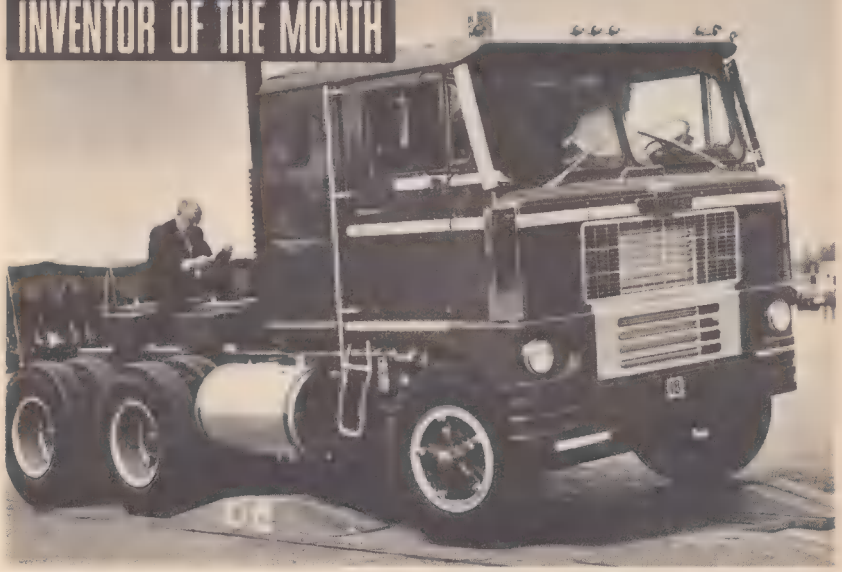
Can mentally maladjusted marriages be saved? Dr. Lorand told the symposium, "Psychoanalysis looks upon much of the family unhappiness caused by mental discord as stemming from neurosis and, therefore, as *an illness which can be treated,* and, hopefully, ameliorated."

Treatment follows the course, again according to Dr. Lorand, of studying and understanding the early environment of the husband and wife and of paying strict attention to the couple's capacity to give and to receive love and to function with normal harmony in a marriage.

Marital crisis may lead to divorce without leading to disenchantment with the idea of marriage. Dr. Joseph Merin, Associate Professor of Psychiatry, New York University School of Medicine, said, "Divorce frequently leads to more marriage or, as Ashley Montague has termed it, to 'sequential polygamy.' "

Non-marriage remains a phenomenon apart, one that pertains only to eight percent of the nation.

INVENTOR OF THE MONTH



At 75, trucker's friend

BEFORE an audience of 250 truck dealers, Elwood H. Willetts seated himself on a White tractor and read a newspaper as he was driven at 30 miles an hour over an experimental course with six-inch bumps. He was demonstrating the soft ride provided for truckers and their cargoes by his rubber torsion suspension.

Science Digest's Inventor of the Month, at 75, drives his own car between his home in Douglaston, Long Island, and Cleveland, where the White Motor Company has begun production of his invention at the rate of 250 a month.

The equipment, for which Willetts recently received Patent 3,171,668, is designed for heavy duty, long-distance truck-tractors that have tandem axles, or so-called twin screws. There are two pairs of drive wheels and the transmission is linked to both.

The Willetts suspension, which weighs 758 pounds, is said to reduce roll and to completely eliminate "wheel hop," as well as cut down driver fatigue and wear-and-tear on the vehicle and the load. The tractor's weight rests on a transverse shaft. From each end of the shaft, arms fitted with rubber springs run to the axles.

It is planned to use the patented suspension also on semi-trailers, most of which have tandem axles. In the past, it has been necessary to build these with a "hard" ride to keep them from tipping over on curves. Softer springs may now be used.

The inventor licenses his devices through the E. H. Willetts Corporation of Islip, L. I. He holds a number of other patents, chiefly on railroad flat cars and tanks and other transportation equipment.

—*Stacy V. Jones*

INVENTIONS PATENTS PROCESSES

The light that measures fog

Fog detectors on an airport runway (top picture) measure fog conditions and transmit visibility information to the control tower. In a harbor (middle picture), the fog detectors warn of navigational hazards such as offshore oil rigs. The Hoffman Backscatter Fog Detection System operates by using an intensely concentrated beam from a radiating diode with a spherical mirror at the rear end of a light gun to create reflections from the fog particles in space (bottom picture). These are then measured by a solar device in a receiver mounted adjacent to the transmitter. When the intensity of the reflection reaches a given level, fog horns are sounded. Information can be obtained from Hoffman, Santa Barbara, California.

Air and sea navigation has been given a boost with a fog-detecing device developed by Hoffman Electronics Corporation's Science Center, Santa Barbara, California.

The device has sensitive fingers of invisible light which probe the atmosphere to determine when fog reaches a dangerous level.

Developed under contract for the U. S. Coast Guard, with financial participation by the Air Force, the fog detector has at its heart a radiating diode. It could also use a laser.

The radiation is fed by a light pipe to a spherical mirror, which converts it to a collimated light. This is then directed into the atmosphere in the area the fog detector is monitoring. If it encounters enough atmospheric particles to register beyond a given level on a receiver adjacent to the light source, fog horns are automatically sounded. Similarly, a warning could be sent to a tower control for guiding aircraft. It could also be hooked up to a direct signalling device to pilots or nautical navigators.

Other versions of the fog detector include a direct path system with a receiver remotely measuring the amount of unintercepted light to reach its solar cells, and a folded

path method which employs mirrors to reflect the beam back to a receiver mounted near the transmitter. The latter is easier to install and maintain, since all active equipment is at one location.

Increasing traffic, new hazards to be protected or avoided, such as offshore oil rigs, and the importance of allowing all permissible traffic movement in peak periods, make fog detection and measurement an urgent need. Frequently the fog density will be far greater or less in certain portions of the landing area than in others, warranting the mounting of a series of fog detectors with planned and coordinated movements.

The manufacturer aims to bring unit costs within economic practicality for extensive application to offshore oil rigs and other air and sea navigational obstacles, airports, harbors and wherever else fog threatens lives and traffic movement.

A research technician at the Massena, N. Y., branch of Alcoa Research Laboratories peers through the back of a magnifying glass used to monitor a "fatigue" test. His interest is in metal, not human, fatigue. His purpose is to evaluate an aluminum electrical conductor to insure its ability to withstand the stresses of decades of service in high winds, laden with ice, or otherwise exposed to the elements.

Bacteria eat poisonous chemicals

A group of soil bacteria that thrives on poisonous agricultural chemicals have been identified by Dr. Kenzo Sotomura, working in the Fermentation Research Institute of Japan. The microbes have been observed feeding on monofluoroacetic acid, which is toxic to rodents and other farm pests. It is lethal to human beings in doses as low as 0.6 mg.

Dr. Sotomura is hoping to find similar microbes that could eat up other poisonous chemicals. The Japanese government has promised to support the research, as the investigations are expected to throw light on the effect on the human body—via vegetables and fruit—of harmful agricultural chemicals.

Britons produce nonsouring milk

One of Britain's biggest dairy companies is selling milk guaranteed not to sour for six months or longer. The milk cannot yet be sold in Britain, but the company, the Express Dairy, has been selling it overseas for several months, and has also been selling it to steamship companies for long cruises.

The milk is heated "very briefly" to 270° F. by passing it over steam-heated plates and then quickly put into plastic-coated cartons. A spokesman for the British National Dairy Council says that the long-lasting milk is "virtually indistinguishable" from the normal product.

Neutron radiographs were photographed from the screen of a closed-circuit television monitor located at the Juggernaut reactor at Argonne National Laboratory. Radiographs were obtained through the use of a neutron image intensifier tube developed cooperatively and built for this application at Argonne by the Rauland Corporation, a subsidiary of Zenith Radio Corporation. Picture at upper left shows a flashlight. Upper right: masonite test object viewed through two inches of lead. Masonite piece varies in thickness and contains several holes. Bottom left: Ten percent thickness change in 1¼ inches of natural uranium. Bottom right: Print of several frames of a motion picture recording showing water entering a one-inch diameter zircaloy pipe through a rubber hose. This technique is also of potential value in biological research because neutrons give an X-ray type image of parts of a plant or animal that are transparent to ordinary X-rays. Its main application, however, will be in the design of advanced reactor systems.

Neutron radiographs

A method of taking television pictures that enables scientists to look through a lead wall and detect a stream of water flowing on the other side has been developed by the Rauland Corporation, a subsidiary of Zenith Radio Corporation, and the U. S. Atomic Energy Commission.

The method employs neutron radiography, a technique that would be impossible with conventional X-ray apparatus. Rauland's contribution is a special electronic tube that converts a picture painted by an invisible stream of neutrons (sub-neuclear particles) into light, and then intensifies the image so that it can be picked up and transmitted by closed-circuit television apparatus. This new technique allows scientists to see neutron radiographs on a TV monitor screen and, because of its ability to resolve moving objects, opens up a whole new field of neutron radiograph motion pictures. The technique is also of potential value in biological research because neutrons give an X-ray type image of parts of a plant or animal that are transparent to ordinary X-rays.

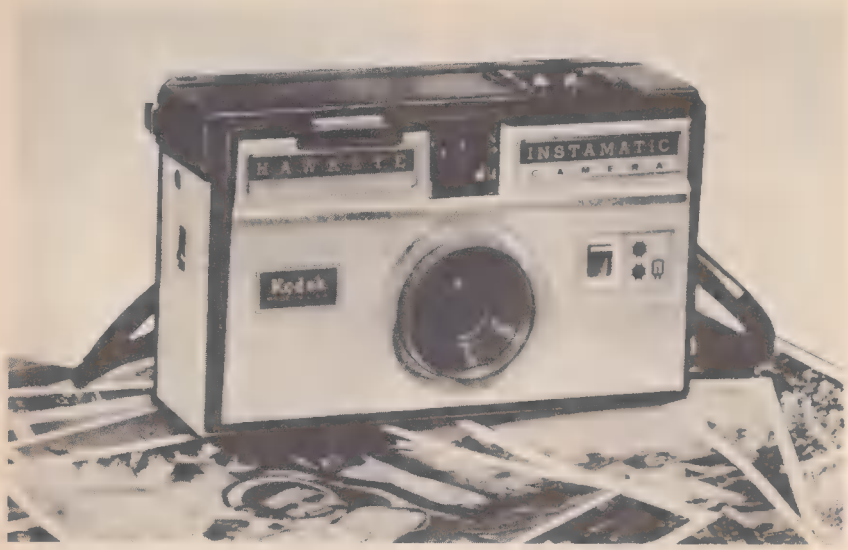
With the new system, scientists have been able to obtain motion pictures of what happens to a piece of irradiated nuclear fuel when it is heated to high temperatures in a shielded container. Pictures of this type—showing what may occur in an experimental fuel loading of an atomic reactor—should be helpful in designing advanced reactor systems for making atomic power.

A Chicago-based electronics manufacturer was unable to test a newly developed undersea antenna until he thought of the Brookfield Zoo, where the porpoise tank has approximately the same salt water content as the ocean. Test apparatus was lowered into the porpoise tank where it showed the new antenna functioning perfectly under near-actual operating environment. A resident of the tank looks on.

Sewage produces chicken feed

A species of algae found in sewage ponds may well serve as a valuable and inexpensive source of chicken feed. Research on the protein composition of *euglena,* conducted by Dr. Yehuda Kott and Professor Alberto Wachs, of the Sanitary Engineering Laboratories of the Technion, Israel's Institute of Technology, Haifa, points to this possibility. The project was undertaken to determine the protein value of *euglena;* the researchers found that it was closer to plant than animal material.

Foods prepared from microalgae grown on synthetic media are already on sale in Japan. The algae which grow naturally in sewage stabilization ponds offer a source of valuable protein. According to the Technion researchers, the ponds produce the algae in sufficient amounts to warrant harvesting. Sewage pond algae are less expensive than those grown in laboratories.



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Saga of the flying clocks

Engineers wheel the atomic clocks along the corridors of the Denver, Col., airport.

THE Hewlett-Packard Company, an electronic instrument manufacturer, now owns two of the most well-traveled atomic clocks in the world.

Accompanied by Hewlett-Packard engineers, the two new lightweight atomic clocks were flown, by commercial facilities, to 21 timekeeping centers in 11 nations in 35 days. The purpose of the 35,000-mile trip was to measure, with millionth-of-a-second precision, exactly how closely those centers agree on the time of day. The operation of the clocks is based on the natural behavior of the atom of Cesium 133, the international standard of time interval measurement.

The odyssey began when the two clocks were put aboard a regularly-scheduled passenger airliner for a trip from the firm's Frequency and Time Laboratories in Palo Alto, Calif., to Washington, D.C., to synchronize them with the standard maintained there by the U.S. Naval Observatory.

The clocks were next flown to the Mojave Desert in California, where the Navy was about to conduct a time synchronization experiment with the Radio Research Laboratories of Japan, using microwave communication via the Relay II satellite. The clocks were flown between the Navy station and the Japanese laboratories as an independent cross-check on the results.

In Japan, checks were made with the standards-keeping center in Tokyo. The clocks then went by station wagon to Kashima, site of the satellite relay experiment. On the return flight, the clocks visited the U.S. National Bureau of Standards' NBS broadcast facility on Maui in the Hawaiian Islands. Back in the continental U.S., they completed the cross check at Mojave, went to the NBS enter at Boulder, Colo., and were re-checked in Washington. Then they left for Europe.

Comparisons next were made with

officials at the Swiss time center at Neuchatel, with the Greenwich Observatory at Herstmonceux, England, with the British National Physical Laboratories at Teddington. Then they proceeded to France for visits at the Paris Observatory and the Centre National d'Etudes des Telecommunications at Bagneux. A visit to the Swedish national time center at Stockholm was followed by one to a Danish laboratory in Copenhagen.

Three visits were made in West Germany. After a second check at Neuchatel, the clocks went on to Amsterdam for comparison there with a Dutch standard, and to Brussels for a Belgian standards comparison. Switzerland followed again, then across the Atlantic for a visit in Montreal and a check with the National Research Council of Canada in Ottawa. Re-checking with Washington, the clocks returned to New York on March 15.

Throughout the journey, all travel was on regular commercial airliners and in private autos.

Synchronizing clocks that are separated by many thousands of miles, with the accuracy needed by modern science, is surprisingly difficult. Ordinary radio communications fall short of the need because of the uncertainty in their transmission time. Microwave communication via man-made satellite is one successful way to do the job. Another, valuable as independent confirmation and cross-check, involves flying one or more atomic-controlled clocks, of known absolute accuracy, among the other clocks to be synchronized.

Why go through all the trouble? There are several reasons. One important one is that a demonstration that widely separated clocks in so many countries may be so precisely synchronized indicates the feasibility of tracking satellites and predicting their courses more accurately. The guidance of interplanetary probes might similarly be improved.

"Time," says Alan S. Bagley, manager of the firm's Frequency and Time Division, "is one of the basic scientific quantities, like distance or mass. We can measure time more precisely than we can measure any of the other physical quantities."

During their 35,000-mile trip, the flying atomic clocks, which weigh 65 pounds often occupied passenger space on jets.

In Tokyo, Hewlitt-Packard engineers brief their Japanese colleagues, at the government standards' broadcast station.

TIPS AND TRENDS

BEWARE. Thousands of Americans who take heparin to prevent heart attacks run the risk of inducing bone degeneration. Dr. George C. Griffith of the USC School of Medicine says large daily doses taken for six months or longer appear to have caused osteoporosis in some patients....Los Angeles smog is better than New York's. An NYC air pollution expert, Dr. Leonard K. Greenburg, says LA's pollutants are irritating but the sulphur dioxide in his city's air may have led to several deaths during smog. Meanwhile, auto spokesmen now say 1968 models could be equipped with exhaust control devices if required to by Federal law. But they add it isn't known if such devices help much.

WANTED. Defense research leaders are looking for refinements of orthodox materiel as well as for "far-out" weapons. The Army needs much more sophisticated ways to find enemy targets; so does the Navy's anti-sub force. Defense also needs quick ways to locate its own units. Immediate Navy needs center around carrier air forces. The Air Force needs improved missile range and accuracy (e.g. with solid fuels). Big dream: "the all-weather, all-terrain vehicle."

COMING: Soviet space weapons that might overtake America's military lead, according to Gen. Curtis E. LeMay...Huge computer centers able to serve 100 or more clients at a time by a technique called MAC (multiple-access computation)...Portable artificial kidneys (2 x 2 x 3 inches).

BOOK IN THE NEWS

Should we be serious about UFO's?

KFS

This "flying saucer" is said to have been photographed over a farm in McMinnville, Ore. Is it a spaceship from another world, as some think, or an ordinary earth object?

by Daniel Cohen

DID you know that we are being watched and perhaps visited by men from other worlds who arrive via flying saucer? You didn't? Well, there is a small but by no means insignificant group of people who firmly and passionately believe just that.

Since the flying saucer or unidentified flying object (UFO) "flap" began back in 1947, the community of believers has shrunk and fragmented into a mass of cult-like groups who spend much of their time attacking one another on obscure points of UFO doctrine. Reading their publications is like reading another language.

But some can break out of their isolation and throw fear and doubt into outsiders. In a recent issue of *True* magazine, veteran saucer warrior Maj. Donald E. Kehoe, USMC (Ret.), must have startled many when he reported that two scientists who had observed an April, 1964, Gemini test launch told him the capsule was trailed by four spacecraft of unknown origin. This, his unnamed informants said, had been observed by official radar operators.

How many people who read the Kehoe article will hear that the Air Force, when questioned by one saucer group on this event, stated flatly that "the objects observed which were detected on radar have

The greatest flying saucer activity in the U. S. coincided with a great boom in science fiction pulp magazines and science fiction films.

been identified as minor structural pieces which routinely break free from the expendable booster portion of the spacecraft at booster separation process"? And even if the diehards do hear the explanation, will they assert, as they have so often in the past, that the Air Force is "covering up"? An ordinary person, being confronted with enough of these stories, will begin to wonder if there isn't something to this UFO business after all. Most of us do operate on the principle that "where there's smoke there's fire."

And just because most people do think this way, a new UFO book to be published this month, *Anatomy of a Phenomenon* (Henry Regnery Co., $6.95) will probably impress many. The author, Jacques Vallee, is, according to the publishers, a French mathematician and astronomer who is presently living in Chicago and working as a consultant on the National Aeronautics and Space Administration's Mars map project.

Vallee's book is not aimed at the UFO enthusiast. He quite correctly states that most of the present saucer groups operate at a "hideous level." His reasonable tone and repeated call for a "scientific" investigation of the subject will appeal to those whose minds boggle at stories of talking to Martians or riding to Venus in a flying saucer.

Vallee starts by stating that flying saucers are not a new phenomenon, but that throughout history, men have been seeing mysterious objects in the sky. He associates everything from Ezekiel's vision to the Miracle at Fatima with UFO's.

Mass of data

Now, trying to bring some pattern out of this type of historical material is a very tricky business. The researcher is confronted with an enormous mass of very heterogeneous data. By careful selection, interpretation and translation, it is possible to prove practically anything. In 1950, Dr. Immanuel Velikovsky presented historical documentation to prove that the earth nearly collided with a giant comet in 1500 B.C., a theory regarded by scientists as silly. Around 1875, Madame Blavatsky produced an astonishing amount of historical support for her Theosophical society. It is not at all surprising that Vallee can find many references to something as vague as "objects in the sky," but to draw a pattern from them goes well beyond the limits of science.

What about more modern sightings?

Reading Vallee's book, a person who did not remember the saucer

scare of the late 40's and the 50's might think that the excitement grew spontaneously. It happens that the greatest saucer activity in the U.S. also coincided with a great boom in the science fiction pulp magazine market and with the release of some excellent science fiction movies.

Today, the Air Force is still carefully investigating UFO's. So far, it has found no evidence that they are from another world. Vallee does not claim, as does Kehoe, that the government is imposing a news blackout on saucers. Rather, he says, its methods of study are wrong.

He states, "We do not classify the reports according to the amount of data they contain; 'insufficient data' alone is not ground for elimination. . . . Think of a physicist discontinuing his research because he does not have 'sufficient information' about the structure of the atom, or the FBI allowing a criminal to escape because the witness's description of his face is not sufficiently accurate!" True, but the physicist has first determined that there is an atom, and the FBI first establishes that a crime has, indeed, been committed. But there is no evidence that there is anything extraterrestrial about flying saucers.

Vallee wishes to include for consideration all reports that are not clearly hoaxes or caused by ordinary effects. But hoaxes and ordinary effects are not always obvious, especially in fragmentary reports.

Vallee bases his suggested method of classification mainly on three factors, the time of the sighting, the place of the sighting and the behavior of the object sighted. Such things as dimension and shape of the UFO are not important, he believes, because witnesses can be mistaken about such things. He also notes that American reports are generally less interesting and important than sightings in other parts of the world. But it is not mere patriotism to counter that American data on UFO's are the best in the world because only in America has there been any intensive investigation of sightings by competent people. The reports are less interesting because these investigations have turned up nothing that would indicate alien spaceships.

Like witchcraft

If Vallee's classification system were applied to another phenomenon, let us say witchcraft, we could get the same results we could expect from a UFO study. With witchcraft we have a large body of information (both historical and modern) with about the same degree of reliability. We would be able to get dates and places and classify different kinds of effects. We could point to various "waves" of witchcraft like the one around Salem in 1692. There would also be a small number of carefully investigated cases which showed that the effects of witchcraft were due to natural causes. (These, of course, would be excluded from the study

because, obviously, they are not witchcraft.) The results of such a study would be very interesting—and totally meaningless. You can not substitute volume of data for reliability.

Let us look at one case that Vallee calls "one of the great classics in UFO history." An Australian Church of England missionary and 37 natives saw a flying saucer hovering a few hundred feet above a mission station in Papua, New Guinea in June, 1959. Inside the craft were four men who waved at them. This sighting, says Vallee, "has a perfectly official character and has remained unidentified after a number of investigations." If this is true, we, indeed, have something very extraordinary. But did it really happen?

Documentation

The only documentation given is the *Australian Flying Saucer Review*. The sighting was reported in an interview with unnamed Australian reporters. Who were the reporters? Where did the report first appear? What sort of investigations were undertaken and by whom? What is official about it?

Stories like this are easy to start and hard to check because they come from some obscure place and Papua is pretty obscure. But when they are checked, they often turn out to be the invention of an ambitious reporter. The history of flying saucers is well stocked with hoaxes. An investigator should be very wary of them. Vallee is not.

In his excellent book on flying saucers, *The World of Flying Saucers*, Astronomer Donald Menzel wrote: "Of the many astronomical observatories in the United States and abroad, none has ever photographed an object that remotely resembled a spaceship. Since 1957, hundreds of members of Moonwatch teams throughout the world have watched the skies to record passages of the many artificial satellites, but no Moonwatch team has yet reported the presence of a spaceship. Radar stations on all continents keep track of every artificial satellite and fragment of satellite orbiting the earth. . . . If an interloper from beyond our planet should join the parade, Space Track stations would at once detect its presence."

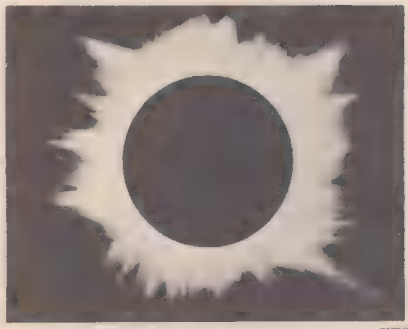
Since Menzel wrote that, satellites have been orbited which photograph every part of the earth and there have been extended manned orbital flights. Still there has been no sign of the elusive UFO's.

You can almost hear the saucer enthusiasts saying, "The aliens are hiding," or, "It's all part of a government conspiracy of silence."

Without a scrap of evidence to support them, and a good deal of evidence against them, the flying saucer enthusiasts will persist in their claims. And if an extraterrestrial spaceship ever does land on this planet, even if it is shaped like a flying box, and never visited the earth before, scientists will be greeted with a loud, but totally unjustified cry, "We told you so."

THE ASTRONOMY STORY

Quiet eclipse



KFS

As THIS issue of *Science Digest* is published, scientists from many parts of the world are converging on a narrow, 8,000-mile corridor of the South Pacific, to view, on May 30, the 38th total eclipse of the sun during this century.

The eclipse observations, in which 125 U. S. scientists are taking a major part, constitute an important contribution to the current world-wide study of the sun and its effects on the earth.

This scientific program began January 1, 1964, and will continue through 1965. It is designated the International Years of the Quiet Sun (IQSY) because it takes place during a low point in the 11-year cycle of sunspot and solar flare activity.

Scientists of 70 nations are participating in the effort to disentangle some of the complexities of the sun-earth interaction demonstrated during the International Geophysical Year in 1957-58, which was timed to coincide with the most recent period of maximum solar activity and, in fact, benefited from the most active maximum ever recorded.

IQSY studies are attempting to establish the quiet-day conditions upon which the sun's explosive processes are superimposed. By studying in detail solar events that are relatively isolated in time, it is hoped that progress can be made in understanding the conditions of equilibrium between the turbulent solar atmosphere and the terrestrial environment. Scientists also hope to find out more about the disturbances originating near the sun's surface that upset that equilibrium.

Celestial coincidence

The eclipse is a product of the celestial coincidence that the moon is of just the right size and at just the right distance to cover the sun's disk but not its atmosphere. It contributes to objectives of the IQSY by providing a glimpse of solar events otherwise masked by the bright sky and the intense light from the sun itself. The observations include:

¶ Direct photography of the extended outer atmosphere of the sun, or corona. During solar quiet, the corona shows a streamer-like structure that is thought to be a visible manifestation of the sun's magnetic field.

¶ Spectroscopic and polarimetric

observations of the light emitted by the corona, to gain information about coronal composition, temperature, magnetic fields, and motions.

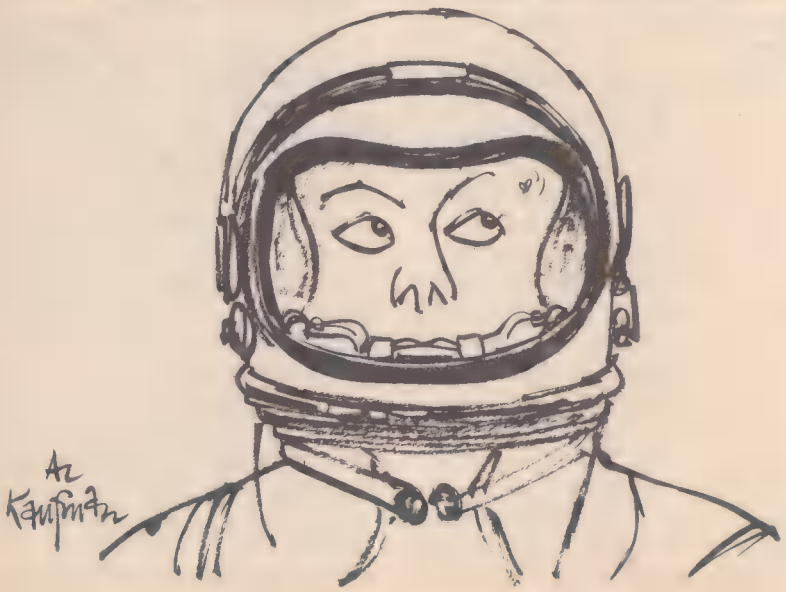
¶ Layer-by-layer analysis of the structure of the solar chromosphere, or lower atmosphere, the puzzling transition zone between the 10,000-degree solar surface and the 3,000,000-degree corona.

¶ Studies of the response high in our own atmosphere to an interruption of sunlight. Normally during the day, the sun's rays keep these layers in a highly ionized state; the eclipse will speed up the changes that take place in the normal day-night cycle.

Coincidentally, the last solar eclipse in the South Pacific occurred during the IGY, in October, 1958. On that occasion, rocket probes were first employed during an eclipse to detect radiations from the corona—primarily X rays—which otherwise would be lost to view through absorption by the earth's atmosphere.

The present solar eclipse is not only timely to the scientific objectives of the IQSY, but also of particular interest because of its unusual length.

Near the midpoint of the eclipse path across the Pacific, the moon will cover the solar disk for more than five minutes. The maximum possible duration of the total phase of an eclipse is seven and one-half minutes; during the 1963 eclipse over Canada and the northern U.S., the sun was hidden for 100 sec.



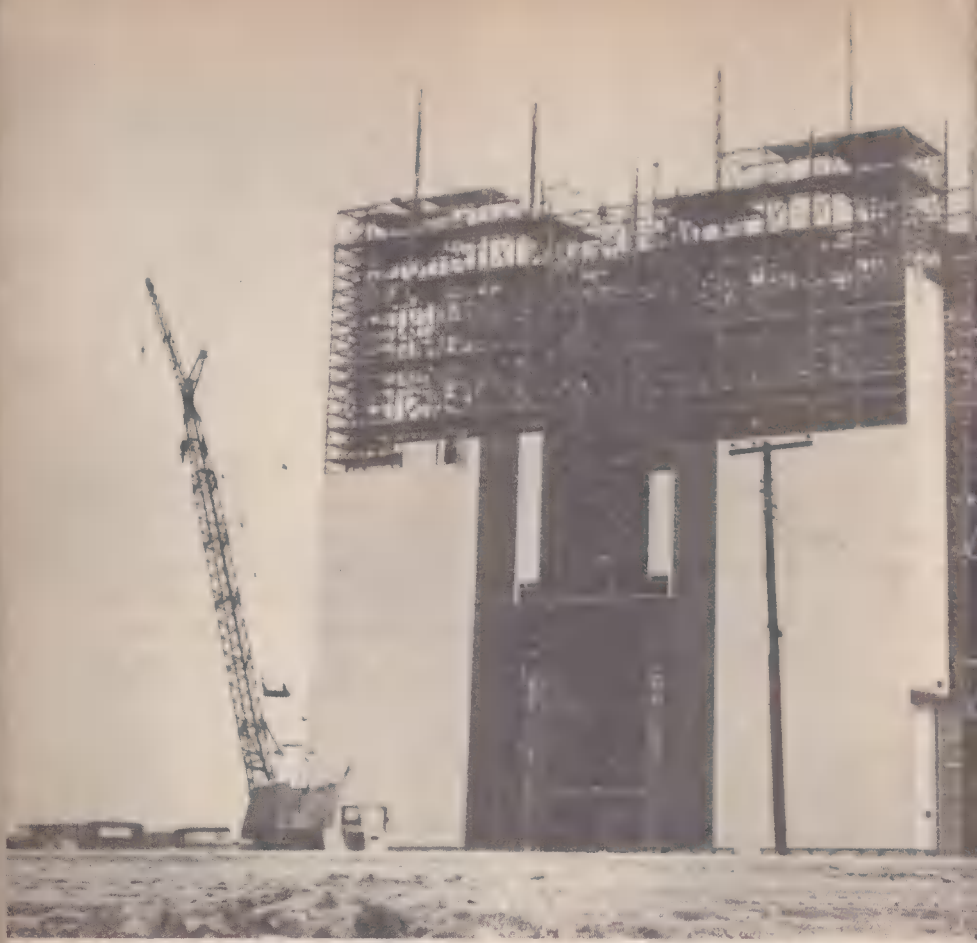
In new NASA area of Cape, mobile launchers are ready for world's biggest rockets.

The amazing new Cape Kennedy

by Hubert Pryor

These doors are 45 stories high

On page 17 of the May, 1963, issue of *Science Digest*, an artist's drawing showed a building 50 stories high designed to assemble rockets for manned flight to the moon. The picture, reproduced at left, resembled the imaginings of a science fiction writer. Today that drawing is a tangible, awesome reality (see above and the pages that follow).



Gargantuan structure near completion will prepare Saturn V's for manned moon shots. It's 525

This building is twice the size

THE world's most spectacular display of modern scientific and technological progress is taking shape today at Cape Kennedy, Fla.

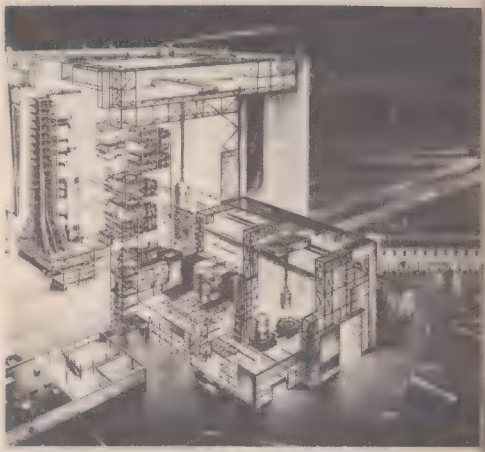
And if you want to, you can take your car down there, drive right through it and see it for yourself.

Hundreds of reporters from around the world took in the sights recently when they visited the Cape for the launch of Gemini 3, America's first multi-manned space flight. Even the most hard-bitten described what they saw as "incredible," "improbable."

Such reactions might suggest a scene of promotional hoopla. In reality, what is going on at Cape Kennedy today is all work, a devotion by thousands of people to a series of projects that add up to the immense project of winning an

ft. high, has twice the Pentagon's capacity.

Aerial view of Vertical Assembly Building shows one of four mobile launchers in background. VAB can handle four Saturn V's. Wing at right is launch control tower.



In cutaway view of VAB, a Saturn is being assembled at left while another, right, moves to launch area. Crawler-transporter carries both rocket and launcher to pad.

of the Pentagon

empire, the endless realm of space.

You may have heard the new Cape Kennedy described as Spaceport, U.S.A.; Moonport and so on. Certainly, it is where space begins. The Gemini flights, the Ranger shots, the Mars fly-by and the satellites sent up to monitor our weather, relay world communications and sample the elements of space itself—all have originated at Cape Kennedy. So have military tests of such missiles as the Titan II, the Atlas ICBM and the Minuteman ICBM. So will tests of the Titan III and the huge Saturn V, the world's largest booster rocket, which will develop 7.5 million pounds of thrust to start man on his first voyage to the moon.

The Vertical Assembly Building on nearby Merritt Island (above),

Stainless-steel monument commemorates the Mercury flights and seven first U. S. astronauts. The tiny gantry they used can be seen in the distant background.

Like fingers pointing at cosmos, newer gantries loom larger toward north end of Cape, above. Below: Reporter reflects tension of every shot—the Gemini 3 here.

where the Saturn V's will be put together, comprises the most staggering feature of this never-never land now blooming in awesome reality.

When you see it, it doesn't seem possible that the first American took a peek at space, a 302-mile shot downrange in a tiny Mercury capsule, just four years ago. The Cape (then called Canaveral) was a lonely bulge of sandy wasteland. Today, gantry after gantry stretches along the 16 miles or so of shore, each complex rising higher than the next as the rockets they handle grew in immensity. As the rockets grew, the launch pads moved north, until today they are topped by the gantries serving the mighty Saturns and Titans.

The military operate Cape Kennedy proper. Indeed, one is surprised to get down there and discover that it is called the Air Force Eastern Test Range. Only now is NASA, with its Merritt Island facilities, beginning to overshadow the military, at least in the sheer size of its plant. Yet the Air Force is itself adding new facilities that are hardly less impressive, among them the Vertical Integration Building, a smaller version of NASA's VAB.

If you go to Cape Kennedy, some of your more knowledgeable companions may awe you with statistics, and there's no place like this for that kind of game. But you'll have plenty to awe you without them.

The visiting hours? Sundays, 1 to 4 p.m. for both the Cape proper and the Merritt Island launch area.

As Gemini 3 lifts into space, it draws all eyes at the press site and for miles around.

The big one

But nothing will match man's first flight to the moon—maybe in four or five years (drawing below). The building is there now; the rocket will be in 1967.

A recent development in solar energy conversion research is this 45-ft.-diameter concentrator in Denver, Colo. It can produce temperatures over 2,000° F., and could provide the daily electrical needs of 30 average houses.

How we're harnessing the sun

by T. E. Weissmann

EVERY day, more than a million billion kilowatt hours of energy shower this planet—about as much as is locked in all the earth's reserves of coal, oil, natural gas and uranium. Yet only a fraction of this immense energy from the sun is harnessed directly. Most of it shoots off into space when it hits the atmosphere and the rest is largely absorbed by vegetation. But spurred by man's thrust into space, research again is focused on new methods of usefully converting the sun's limitless energies.

The potential gains are high. To

meet the world's total energy needs, for example, it would only be necessary to capture .2 percent of the solar energy absorbed by the bare earth of the entire world. To meet the power and heat requirements of Canada and the United States would require only about 100 square miles of Arizona desert to generate—with suitable facilities of course—the required energy from the sun. Scientists generally believe that it is possible to develop about 440,000 hp-hr per acre per year from solar energy.

To tap the sun's energy, two approaches have been followed. One is to directly convert sunlight into electricity by means of solar cells or batteries; the other—an indirect method—by solar engines which rely on parabolic reflectors to collect sunlight to heat steam boilers which in turn drive generators.

Solar cells have so far been dominant in low power applications and are exceptionally successful in communications satellites, but also in some terrestrial cases as well. Solar engines, by contrast, are expected to make their biggest impact in high-power applications for space vehicles and the like.

The big breakthrough in man's long quest to harness the sun came in 1954 when three scientists of the Bell Telephone Laboratories devised the first solar battery, consisting of a number of individual silicon solar cells, each capable of converting sunlight into electrical power with much higher efficiency than any previous photovoltaic device, such as the thermocouple and the photoelectric cell—whose efficiency is about 1 percent.

Today's solar batteries, such as the ones in use on communications satellites are radiation resistant and have high efficiency levels, about 12 percent in sunlight, while non-radiation resistant types have efficiency levels comparable to that of steam and gasoline engines. (The theoretical efficiency level of solar batteries is usually given as 20 percent.)

There's little doubt that solar cells carry a major role in space explorations. Without them, continuous space communications would perhaps be impossible and certainly less reliable. Now their reliability is astounding.

In earthbound applications, solar

Technician examines five-ft.-diameter aluminum disc used in a demonstration. Solar rays were reflected from the mirror-like concentrator to the aluminum, melting the metal within seconds.

Control room at Denver plant keeps Goodyear Aerospace-built concentrator locked on sun. Facility is largest of its kind.

cells have also established themselves. In 1955, in Americus, Georgia, 432 solar cells were placed atop a telephone pole, angled to get the best exposure and connected to the rural telephone circuit to successfully provide electrical power. Excess current from the cells went into storage batteries to power the systems at night and during marginal weather.

While it takes about one square yard of solar cell surface to deliver power at a rate of 100 watts, it is interesting to note that the solar cell's output and performance increases as the temperature decreases, thus making it ideal as a space vehicle power source. Solar cells are also expected to find wider use in transistorized telephone repeaters in remote areas, in mobile radios, in power sources for seashore beacons, in weather stations on mountain tops and in an unusual application . . . to provide power for a helmet with built-in walkie talkie.

Key factor behind the solar battery concept is of course the cell itself and its unusual characteristics. Each cell consists of specially-treated, wafer-thin discs of silicon of different electrical characteristics. The specially prepared silicon is obtained from common sand—available in abundant quantities. A minute amount of boron, in a ratio of one part boron to a million parts silicon, is added. The two materials are melted together to form a single-crystal ingot of doped silicon. The ingot is sliced into precise wafers and each is placed into a quartz tube containing vapors of phosphorous compounds. The assembly is heated and the phosphorous atoms are deposited on and within the silicon surface and diffuse into a thin layer. The two silicone types have different electrical characteristics and the boundary layer between the two regions (which is less than 1/10,000 of an inch under the wafer surface) is called the p-n junction, the key factor in solar cell performance.

Solar into electrical energy

When light strikes the treated surface of the wafer, it splits off an electron from its normal position in the crystal's lattice, leaving a positively charged "hole" or vacant spot. The p-n junction provides a built-in electric field that pulls the electrons into the n or negative side of the junction and the holes into the p or positive side before many of them re-combine. The electrons are thus collected by the junction and with suitable contracts and leads to the two sides, the resultant current is fed to an external circuit. The actual conversion of the light into electrical energy is seen as

happening in the creation of "electron-hole pairs" and cells convert as much as 12 to 15 percent of the energy of incident sunlight directly into electricity.

Solar cell development is moving ahead at a considerable clip. Power systems with a life expectancy greater than the equipment they power can now be produced. While solar cells have not yet found wide use in non-space applications, scientists are hard at work narrowing the cost gap and improving power storage methods and facilities.

For large electrical power requirements over sustained periods, the solar engine concept is favored by many, and is also subject of some of the most exciting research in solar energy conversion. Power requirements of the order of up to 30 kilowatts for space missions will likely be met by solar engines whose reflectors are constantly oriented to the sun—regardless of spacecraft motion—to collect the sun's rays and to focus them on steam or organic fluid boilers to drive electric generators.

One mile above sea level, at Denver, Colorado, within the shadow of the Rocky Mountains, rises a three-story high structure that houses the latest thing in solar research. It is a 45-ft.-diameter parabolic concentrator that produces temperatures in excess of 2,000° F. It is a key part of this, the world's largest solar tracking facility, and vital to the United States Air Force Advanced Solar Turbo-Electric Concept (ASTEC)—a project designed to provide long-duration space vehicles with an unlimited supply of electrical energy from solar radiation. The heat generated at the focal point of this concentrator could provide the daily electrical needs of 30 average houses, if transformed into electrical power. The facility recently went into operation at Sundstrand Aviation-Denver and is used to test various components destined for the ASTEC project, such as solar concentrators, heat receivers, turbine alternators and radiators.

The equipment can accommodate concentrators up to 60 ft. in diameter and the sun's rays are concentrated into a focal point eight inches diameter, at a focal length of 19.6 feet.

The Denver facility is the major scientific tool in the ASTEC project. It also provides a means of accurately aiming large solar energy collectors at the sun throughout the daylight hours and assists in evaluating the efficiency and reliability of solar power systems.

The tracking facility has provi-

While the sun is not yet competitive as a commercial power source, it is one of the outstanding ways being studied to propel missions into space.

sions for automatically locking onto the sun in its daily course.

One of the major development problems yet to be solved is to determine what type concentrator to use. For space use the problem of cloud cover is non-existant, but instead there is the problem of thermal energy storage while the space craft moves in the earth's shadow. This can be taken care of, according to Sundstrand's Dr. John May, through the use of the heat of fusion of a high-temperature salt, such as lithium hydride or fluoride. This method, of course, is not too desirable for terrestrial uses, due to the long periods of darkness and the large quantities of salt that would be needed. For this reason, suggests Dr. May, it would appear that the earliest uses on earth would be perhaps for irrigation pumping, for example, where a continuous operation is not required.

"Ultimately, though, other applications, can be expected," says Dr. May. "Some of these might be power for remote weather and radar stations, battery charging for mining or similar applications and other allied uses."

For years, great effort towards use of solar energy has been expended, in some cases with success. Houses have been heated . . . and many of them not in sunny climes. Houses have been heated with the sun's "free" energy in Massachusetts since 1948, and under relatively unfavorable circumstances it has been found possible to meet 80 percent of the needed comfort and heat from solar energy, a percentage that hit 100 in Arizona.

There's little doubt that the sun's storehouse of "free" energy is a challenge to our scientists. While the sun is not yet competitive as a commercial power source, it is rapidly becoming one of the important ways being studied to propel man's bold missions into space.

Air pollution peril

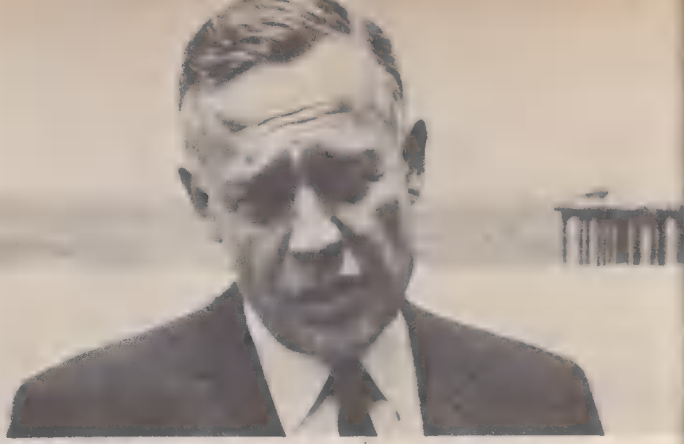
The air we breathe can kill us, an air pollution expert testified recently. It may take 20 years to prove it beyond question, he said, but "to wait until such definitive results are obtained would be to wait too long. . . . By then, we might have forfeited our chance to safeguard the population against serious chronic disease and the shortening of life span," said Dr. John R. Goldsmith, an epidemiologist for the World Health Organization. He added, "Most air pollution standards refer only to 'safe' levels of specific pollutants, but the air is a mixture of many such items. The mixture of pollutants can have a greater effect than the single pollutants."

All photos Three Lions

Dr. Henry Menard, Jr., of Scripps studies a three-dimensional drawing of the Pacific floor off the California coast. Drawing shows general relationship of undersea masses.

The biggest classroom in the world

At the University of California's Scripps Institution of Oceanography, La Jolla, scientists study secrets of the seas at their back door.



Dr. Roger Revelle, a scientist of the sea since his youth, was Scripps director until Oct., 1964. He took a position at Harvard and was succeeded by Dr. F. N. Spiess.

Strange flying fish from Indian Ocean (held by Dr. Richard Rosenblatt) was caught on a Scripps research vessel. It was added to the Scripps collection of deep-sea fish, the world's largest, comprising over 125,000 specimens in all.

Dr. George Bien, left, prepares a sample of gas from sea water. Its age will be measured by carbon 14 method in isotope lab. Dr. Jeffery Frautsky is at the right.

William Riedel, Australian assistant research geologist, studies a sample of core taken from the ocean bottom. Kept in cold storage are hundreds of core samples taken from ocean bottoms all over the world for study by Scripps scientists.

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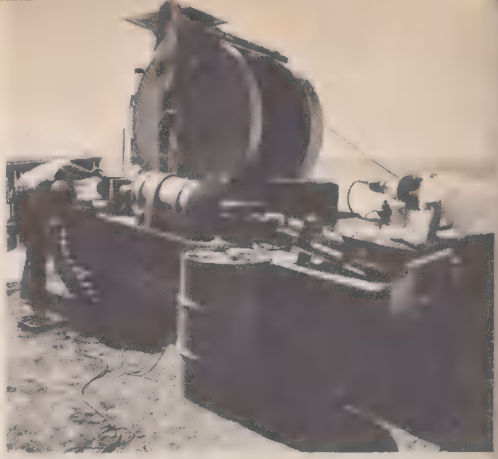


One type of undersea exploration is conducted by the RUM machine (Remote Underwater Manipulator). This vehicle has a long arm on the front equipped with two TV cameras. The rig is completely waterproofed and moves along bottom on tracks.

Three Scripps researchers load a buoy replacement on their outboard motor boat, before lowering it into the water and setting out on a brief trip in behalf of a kelp research project for the Institution.

The famous Scripps Institution is a department of the University of California. Its campus reaches to the oceans far beyond this palm-lined lawn at La Jolla.

A marine biology student works on project to study the basic life habits of the red crab which invaded the waters of Southern California by the hundreds of thousands in the past few years, carried there from their normal home by warmer ocean currents. Scope of Institution's research will be augmented soon with new "floating laboratory" and 3-story physiological lab.

Above: Work is now in progress to restore the great Moon Pyramid built by the mysterious people of ancient Mexico known to archaeologists as the Teotihuacanos.
Left: Stone statue of the water goddess.

New marvel: Mexico's pyramids

by Helen M. Kovar

THE greatest metropolis in the Americas in pre-Columbian days is coming to life again.

It is Teotihuacán (pronounced teh-oh-tee-wah-KAHN), 30 miles northeast of Mexico City. The ancient city was mysteriously ravaged by fire and plunder 1,200 years ago. And until recently, little was known about its citizens, who ruled an empire from Central America to what is now the U.S.

The story of these extraordinary

All photos by Anton J. Kovar

Sculpture on the facade of the newly restored Quetzalpapaloti Palace in the Ciudadela of Teotihuacan. Main design is thought to represent Taloc, god of water and rain, the city's most important deity.

people and their capital began to emerge about 1901, when the city's now-famous Sun Pyramid was reconstructed. A few years later, a fortress-like structure called the Ciudadela (see-you-dah-DEH-lah) was restored.

In the last two years, excavations financed by a Mexican Government grant of 1½ million dollars have uncovered a large part of the ancient city.

When the fierce Aztecs conquered the tribes of the area, Teotihuacán already lay in ruins. Its origins were shrouded in the mists of legend. Aztecs held the ruins as sacred and their last emperor, Montezuma II, often made pilgrimages to the holy place.

The Spanish conquerors found huge bones in the vicinity, which lent credence to the legend that Teotihuacán had been built by ancient giants.

The Toltecs, who had preceded the Aztecs in the domination of the Valley of Mexico, had been so impressed by the size of some of the structures that they believed that only giants could have built them. They found support for this belief in the finds of huge bones in the general vicinity of the site. The Spanish conquerors also lent credence to this legend. Among the first presents sent to the Spanish king from the newly conquered land was the large femur of a mammoth.

Confusion about the origins of Teotihuacán persisted for a long time. Even archaeologists did not know who had built the city. As late as 1944, a noted American archaeologist published a book in which he assumed that Teotihuacán was Tula, the legendary capital of the Toltecs. We still do not know the original name of the city, nor what language the Teotihuacanos spoke. Teotihuacán is an Aztec name meaning "the place of the gods," or as some would have it, "the place where men become gods." The names of the various pyramids and other structures are likewise in Nahuatl, the language of the Aztecs.

Who, then, were the Teotihuacanos, the builders of this imposing metropolis? Their precise origin is not known. They may have been a mixture of Totonacs from the Gulf Coast and of Nahuas from western Mexico. One thing is certain, however. Everything we know about them shows clearly that they did not belong originally to the central plateau of Mexico on which they built their capital.

Biggest advance

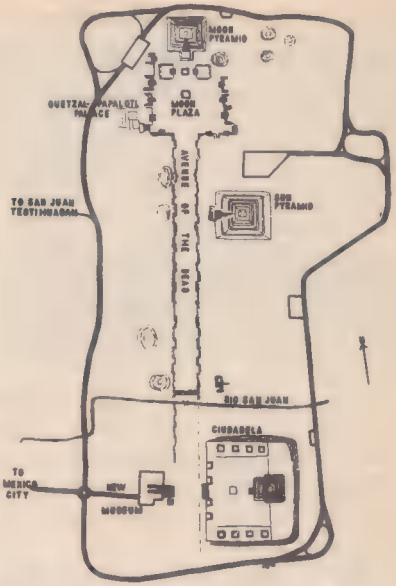
Many excavations have been undertaken throughout the years at Teotihuacán since 1910. The biggest advance toward understanding of the culture of Teotihuacán was initiated in 1962, when thanks to the interest of former President López Mateos, the Mexican government allocated the sum of about $1½ million dollars, quite a substantial amount considering the economy of Mexico, to promote new excavations.

The Moon Pyramid was almost completely restored, the Avenue of the Dead was cleared of rubble and the temples bordering it, repaired. Many structures, such as the Quetzalpapalotl Palace (Quetzal-butterfly palace) regained some of their original splendor. New murals, sculptures, pottery and other artifacts have also been uncovered. In a new museum, at the south end of the Avenue of the Dead, many of the finds, old and new, are shown in exhibits.

From all indications, the Teotihuacanos were organized into a highly cultured, theocratic and sharply stratified society. At the top level were the religious leaders, who dominated every facet of Teotihuacán life. A formalized religion based on worship of the water or rain god, Tláloc, grew in a short time to the heights of power. This great power is expressed in the ceremonial center of Teotihuacán with its towering pyramids and adjunct structures. The grandiose planning and simplicity of concept has no equal anywhere in the world. Tláloc also had control of all the different forces of nature, including lightning and the clouds, and all living things, both animal and vegetable.

Other gods were also venerated, among them the god of maize and many minor deities such as the gods of butterflies, of fertility, springtime and renewal of life. By and large, it can be said that, with minor exceptions, the religion of the Teotihuacános was a cheerful one, deeply rooted in nature and very much unlike the bloodthirsty religion followed by the Aztecs.

Judging from the figurines excavated and the mural paintings, the priests wore rich attire, resplendent with feather head-dresses, fine cotton cloaks adorned with beautiful designs of pieces of shell and jade, sandals and jewelry. As recent excavations seem to indicate, the priests usually had living quarters within the ceremonial center, along the Avenue of the Dead.



Map of the Teotihuacán ceremonial center, showing the new highway encircling the area and the recently opened museum.

Beneath the priest-kings and the nobility there existed a large class of artisans classified according to profession and living in their own specific quarters of the city. Among these groups were potters, sculptors, musicians, dancers, painters, weavers, carpenters, etc. who worked under the rulers' orders. To feed this large group of consumers and the rulers, there must have been an even larger group of producers, farmers, fishermen and possibly hunters. Those needed to act as a labor force in the huge construction projects in the city were probably drafted from this group.

The work they performed in building just the Sun Pyramid was immense. Its sides at the base are

The builders of Teotihuacán lacked machinery and beasts of burden; all the materials had to be moved and lifted by human strength alone.

over 700 feet long and its height is over 200 feet. Its volume is over 1 million cubic yards. The inside consists of adobe bricks, soil, and stone reinforced with tree trunks. Since Teotihuacános lacked machinery and beasts of burden, all the materials had to be transported by human strength alone. The pyramid was faced with stone which was covered with plaster and painted red. There is also a staircase leading from the bottom to the top of the pyramid.

The building of the Moon Pyramid was a task only slightly less than that of the Sun Pyramid. Leading from it is the Avenue of the Dead, nearly two miles long and flanked by a great number of pyramidal structures. At the southern end of this Avenue is the Ciudadela, a fortress-like enclosure with sides over 1300 feet long and containing many structures. Scattered over the area are a vast number of mounds each containing a small pyramid or some other kind of building.

Housing varied according to the station occupied in the society. The rulers and nobles lived in palaces. Several of these have been uncovered and partly reconstructed. Many of them, such as Xolalpan and Tetitla, were large and beautifully decorated with murals.

One striking fact about all structures is the preoccupation with drainage. Even the poorer buildings were equipped with systems of drainage; floors and roofs were usually tilted to allow rain water to go down drains in the patios. These smaller drains met eventually in larger rectangular drains near the edge of the buildings. The water thus collected drained away in large ditches. There is no proof that the Teotihuacanos made any conscious effort to use this water for irrigation purposes. It is possible, however, that at least some of the water was stored in large basins to be used in times of drought. This is still the custom today in many parts of central Mexico.

Artisans and farmers

The artisan class probably enjoyed a fairly good life, with the best materials of the time available to them for their creative efforts. The life of the farmer was probably harsher. He had to produce enough to satisfy his family's hunger and also a surplus, which probably went as tribute to the rulers.

The main crop was maize, but many others were also cultivated, such as peppers, squash, tomatoes, beans and maguey. Hunting and fishing provided the luxury of meat for this primarily vegetarian people. Ducks, lizards, rabbits, deer, tur-

keys and armadillos are among the animals represented on murals and pottery. Wilder animals such as the eagle, coyote, jaguar, badger and wolf were no doubt found on the thickly forested mountain slopes around the valley. All sorts of water animals, such as fish, turtles, snakes, and water fowl, were available from Lake Texcoco and nearby streams. Ducks were captured by hunters in canoes. Fishermen set nets and speared fish. Many insects and larvae were also considered good tid-bits by the Teotihuacanos. Fried maguey worms are still a delicacy in the area. Grasshoppers, dragon flies and honey ants were also eaten. Bees were kept by many farmers, providing wax and honey.

On certain days chosen by a special calendar, all Teotihuacanos participated in religious festivities. These were held in the open air in the large plazas of the ceremonial center. Dancers and musicians performed in gay apparel dressed like tigers, monkeys, eagles, butterflies and other animals. The priests dressed the part of some of the gods.

Physically the Teotihuacanos must have been of only medium height, with somewhat slanted eyes and a Mongoloid look, if we are to trust their own figurines and paintings. They were brachycephalous (short-headed) but, as the recovered skulls indicate, they used to artificially flatten their heads. They either shaved off all the hair or left only a few tufts, and then covered their baldness with fancy head-

Over one million cubic yards of fill were needed to build the Pyramid of the Sun.

pieces or caps of various shapes, very often animal and ornamented with all types of jewelry and feathers.

Other men's clothing depicted in the Teotihuacán murals and pottery consisted of a loin-cloth or kilt, sandals, and an assortment of earplugs, necklaces, bracelets and feather head-pieces. The women wore a skirt held up by a belt and a short blouse topped with a woven triangular piece front and back, now called the quechquemitl. They also wore a turban, jewelry and sandals.

As to the artistry of these people, one has only to consider the fine division of crafts work and the diversity in materials employed: obsidian, mica, sea shells, jade, wood, clay, bones, volcanic rock, textiles and feathers. Metals, including the gold which played such a role later during the Conquest, were completely unknown to the Teotihuacanos.

Although no books or codices, as

The big question that remains is: What caused the mysterious and sudden disappearance of this greatest of all early Meso-American cultures?

they are called, have been found, some glyphs appear in murals, pottery and sculptures which prove that the Teotihuacanos used a 260-day calendar and the bar-and-dot number system.

Teotihuacán came into being about the time of Christ, although its roots in the archeological zone appear to go back as far as 300 B.C. Around the middle of the 7th century, this seven square mile metropolis was suddenly destroyed and ceased its function as a great ruling and ceremonial center. Some refugees from it appeared at Atzcapotzalco, a small town southwest of Teotihuacán, which now forms part of the northwestern end of Mexico City. For a while they tried to keep up their traditions and way of life, but eventually they disappeared in the general turmoil which preceded the Toltec takeover of the Valley of Mexico.

The big question remains: What caused the ruin of this prestigious city? Some suppose that uncivilized tribes, bursting out of arid northern Mexico in search of more favorable places, burned and sacked the city. If Teotihuacán had been the only city thus affected, this supposition would appear probable. But the fact is that other classic centers of civilization in southern Mexico, Guatemala, and as far as Copán in Honduras, suffered the same fate. Beginning with Teotihuacán in the middle of the 7th century, and sweeping southward, it would appear as if an epidemic had swept over the centers of classic culture so that by the end of the 9th century, they were all abandoned. This would seem to indicate a social upheaval rather than attack by an enemy.

There may also have been a food crisis at Teotihuacán, brought on by several years' poor crops. These in turn might have been caused in part by erosion from over-use of land and over-cutting on the surrounding mountain slopes. The climate definitely became drier at this time. This food crisis or religious differences may have caused internal conflict between the rulers and lower classes. As the city became so great and so wealthy at the expense of the lower classes' labor, the whole theocratic structure perhaps toppled of its own weight. In this case, a revolt of the lower classes could easily have destroyed the masters and the city.

Probably a combination of these causes united to destroy the greatest of all early Meso-American cities. At any rate, we now have a better picture of the talented Teotihuacanos.

As excavation goes on at the zone, more will be learned of the rise and fall of this amazing people.

What is the e. m. spectrum?

Your radio and television, the ultraviolet rays that tan you, your dentist's X-ray, even that new wonder, the laser—all are part of one of the most important scientific concepts in our life today. Here is a simple, complete wrap-up.

by H. Hellman

WHEN you drill a hole in a piece of wood, the drill bit transmits the energy of the electric drill to the wood. But that new wonder, the laser, can bore holes in steel without touching it, even in a vacuum.

Is this some new and magical force that has been created? Not at all. The operation of the laser is based on the same principle—the electromagnetic wave—that explains the action of X-rays, light, TV, radio and radio astronomy, the sun's heat, microwaves, radar, and a myriad of other, seemingly unrelated actions. All of these represent forms of energy that can travel through a vacuum. A strong enough beam of light could even support a light object, such as a postage stamp, in a vacuum.

If you're puzzled by how energy can go through a vacuum, you're in good company. This has puzzled scientists for thousands of years.

The most obvious answer was given as part of a theory of vision first propounded by the Greeks in 500 BC. This "emission" theory held that something is emitted by bright objects and that when this thing enters the eye it is able to affect some sensitive part of the eye and so give rise to the sensation of sight.

Although the theory of light started as the study of vision, this is not, to the physicist, the most important part of the subject. To him, light is a form of energy which travels from one place to another. It can interact with matter (photocell or photographic film) and can be transformed into thermal, electrical, or chemical energy.

So the question of course arose: just what is being emitted by bright objects? Clearly, minute particles are a possibility. But it wasn't until Newton formulated his Laws of Motion (which are still used to describe how forces cause objects to move) in 1687, that a scientific theory of particle emission could be formulated. This Newton did, and he reasoned this way: Light travels in straight lines (or so it was thought at the time); and one of his laws tells us that particles travel in straight lines unless deflected or stopped by some force or object. It therefore appeared to Newton that

light should be described as a system of particles which follow his laws of motion.

Newton had also shown that white light is a combination of colored lights. He demonstrated this in 1666 by passing it through a triangular piece of glass, and then recombining the colors back into white light through another prism. He tied this idea in with his particle theory by suggesting that the different colors of light consisted of different particles, and that mixtures of colored light were merely mixtures of these particles.

But the particle, or corpuscular, theory couldn't explain a phenomenon called double refraction, and an alternative theory was proposed at about the same time by the great Dutch mathematician and physicist, Christian Huygens. He treated all space as pervaded by a subtle and elastic medium, the "luminiferous" (light carrying) ether, through which waves are propagated in all directions from a light source. These waves or undulations spread in a regular spherical form from the point of origin, just as waves produced by a stone dropped in water spread in circles (see "What Is a Wave?" page 74).

Newton was open minded enough to consider the wave theory, but he remained partial to the particle theory, saying, "A bell may be heard beyond a hill which intercepts the sounding body . . . but light is never known to bend into the shadow."

However, the English physician Thomas Young showed in 1801 that light does indeed bend. However, the bend is extremely small, owing to the minuteness and immense speed of the waves. Young was the first to show, for example, that the wavelength of light was about one sixty-thousandth of an inch. By way of contrast, an ordinary radio wave has a wavelength of more than a thousand feet. Is it any wonder that radio waves can go around buildings while, to the feeble measuring apparatus we call our eyes, light appears to travel in straight lines.

Light waves

Once it was shown that light does bend, it seemed quite clear that light consisted of waves, in spite of the fact that the great Newton had favored the particle theory. But waves of what? The only explanation seemed to be the luminiferous ether we mentioned before. Although objections were raised to its use, there seemed no other way to explain how light energy gets from here to there.

The work of such men as Galileo and Newton had convinced the scientists of the 18th and 19th centuries that it was possible, even desirable, to have a mechanical interpretation of nature, one in which everything, even the ether, was explainable in ordinary mechanical terms. Numerous (unsuccess-

Mr. Hellman is Manager of Information Services, Aerospace Group, General Precision, Inc.

THE ELECTROMAGNETIC SPECTRUM

Wavelength (in.)	*Name*	*Produced By*	*Effects*	*Uses*
Up to .0000000055 (5.5 trillionths)	Gamma rays	Atomic disintegration; radioactivity	Penetrate all matter; expose photographic film; ionize gas	Atomic investigations; therapeutics
.000000023 to .00000053	X-rays	Stoppage of high-speed electrons by a metallic target	Less penetrating than gamma rays; expose photographic film; refracted by crystals	X-ray photography; medical diagnosis; therapeutics
.00000053 to .000015	Ultraviolet rays	The sun; mercury arc; ionized gases	Expose photographic film; produce phosphorescence; induce chemical reactions	Photography; identification; medicine; disinfecting
.000015 to .000031	Visible light	The sun; hot bodies; ionized gases	Exposes photographic film; visible illumination; induces chemical reactions	Illumination; photography; optical instruments
.000031 to .039	Infrared rays	Radiated heat	Expose special photographic film; produce sensation of heat	Special photography; heat lamps; industrial drying; identification of chemical compounds
.039 to 390	Ultra-high-frequency radio waves	Ordinary and special types of electronic oscillators	Produce an electric current in a conductor; can be reflected and focused	Radar; television; FM radio; experimental
390 to 1,300,000	Radio waves	Radio transmitters; vacuum tube oscillators	Produce an electric current in a conductor; reflected from upper atmosphere	Communication; radio
Above 1,300,000	Alternating current	A coil rotating in a magnetic field	Electromagnetic induction; electrical heating; chemical and physiological changes	Transportation of electrical energy through conductors; source of alternating voltage

From the Harper Encyclopedia of Science, edited by James R. Newman. (c) 1963 by Harper & Row, Publishers, Incorporated, and Sigma, Inc.

Visible light is only one small segment of the mostly invisible electromagnetic spectrum.

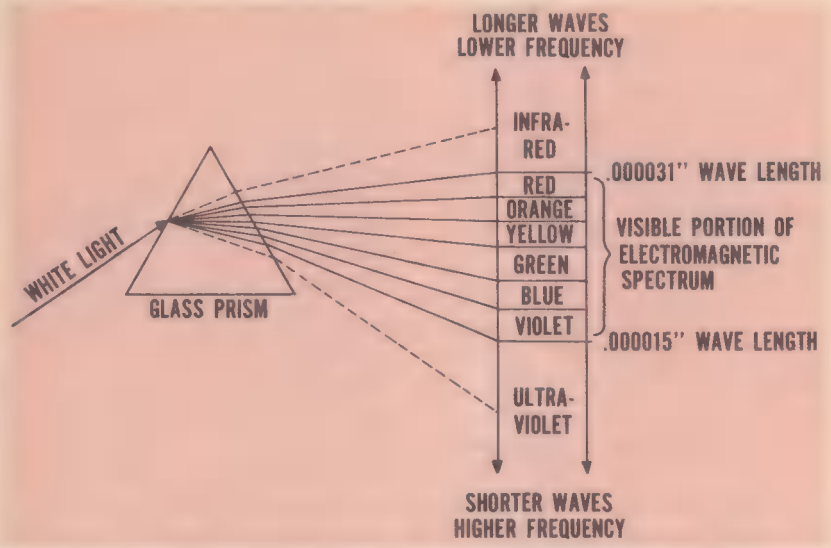
ful) mechanical models were conceived in an attempt to "explain" the ether. One was even built, in about 1850, by the great English scientist Lord Kelvin; it was composed of spheres, bars, caps and flywheels.

Back in 1800, the English astronomer, Sir William Herschel, was experimenting with the colors of the spectrum formed by passing white light through a prism. But he observed something very peculiar; a thermometer placed in the different colors registered higher as it moved from the violet to the red end. And the thermometer continued to rise as it was moved beyond the red, where nothing could be seen. It wasn't until the 1830's that it was realized that this kind of heat (radiant, as from the sun) had all the properties of light.

But light and radiant heat can be reflected and absorbed whereas gravity, which is similar in many ways, is not. Hence there must be two kinds of ether. Come to think of it, electric and magnetic fields also act in a vacuum. Four different kinds of ether?

Not only that, but the tremendously high velocity of light (186,000 miles per second) would require that any medium transmitting it be more rigid than steel. Yet this same medium would have to present little or no resistance to the movement of the earth and other heavenly bodies through it. An unlikely combination.

Since much of what physical science was trying to explain was based upon this ether, the whole, carefully conceived mechanical structure of physics seemed to be tottering, and, indeed, in danger of collapse. But, as in all good thrill-



A beam of white light is divided into its constituent colors when passed through a triangular glass prism because the colors are bent in varying degrees by the glass. This effect is called dispersion. It was first demonstrated by Sir Isaac Newton in 1666.

ers, a hero came thundering to the rescue (although it is highly unlikely that the gentle, nearsighted Scottish physicist James Clerk Maxwell ever thought of himself in those terms). Using the long suspected, but only recently discovered, connection between electricity and magnetism, Maxwell took several bold steps in the 1860's and 70's.

For one thing, even though it appeared clear that electricity did not flow along a non-conductor or dielectric, Maxwell postulated the existence in a dielectric of a particular type of current, which he called a displacement current. By treating it as an ordinary current, with the appropriate magnetic effects, he was able to arrive at a set of equations (now called Maxwell's equations) representing the whole science of electromagnetism. The form of these equations was that of a wave equation, which had been worked out earlier.

Oscillatory phenomenon

Hence an electric discharge, which had been observed, appeared to be not an instantaneous but an oscillatory phenomenon (see "What Is a Wave?" page 74) in which waves of electric and magnetic force were emitted into the surrounding space (which is a dielectric). And the surprising fact emerged that the velocity of these waves, calculated entirely from known electric and magnetic quantities, was equal to the measured value of the velocity of light. Thus it seemed clear that electrical disturbances and light

were members of the same family—that is, that light was an electromagnetic wave motion, which in turn could be explained as a combination of moving and changing electric and magnetic fields. Thus at least three of the four ethers were shown to be one.

Maxwell also expanded on Faraday's work with "fields" and "lines of force." For the physicist of the early 19th century, the concept of the field—a region in which a "test body" such as an electric charge or tiny magnet experiences a force—did not exist. For him only substance and its changes were real.

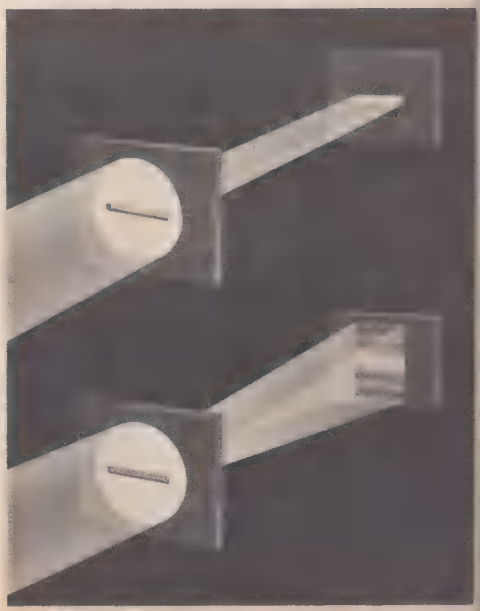
Maxwell's equations still today form the backbone of the science of electromagnetism, even though they were published almost a hundred years ago. Just as Newton's laws of motion permit us to understand the motion of particles, these equations enable us to understand, describe and predict the action of electomagnetic waves.

And perhaps best of all, Maxwell reasoned that since these waves are produced by vibrations or oscillations of electric particles, and since these particles could undoubtedly oscillate at many different rates, there should be a whole family of electromagnetic radiations (which have since been produced) at frequencies both greater and smaller than those of light. Einstein has called this theoretical discovery of electromagnetic waves one of the greatest achievements in the history of science. The totality of these different waves (see chart on page 71) is called the electromagnetic spectrum.

Unfortunately, it wasn't until 10 years after Maxwell's death in 1879 that these waves were actually demonstrated. In a wonderful set of experiments, Maxwell's greatest pupil, Heinrich Hertz, generated such waves by purely electrical means and detected them. He showed that even though they couldn't be seen or felt, they could excite a spark and could be reflected, bent, and even made to form shadows.

Hertz pointed out that "Optics is no longer restricted to minute ae-

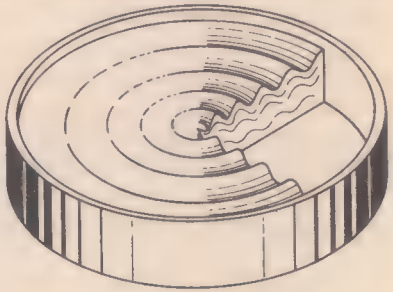
Top: Expected pattern of light and shadow. Bottom: Actual pattern. (Slit width has been greatly exaggerated.) A diffraction pattern of this nature can be readily observed by looking at a point source of light through a narrow slit formed between the fingers in front of the eye.



ther waves (i.e., light), a small fraction of a millimeter in length; its domain is (now) extended to waves that are measured in centimeters . . . and kilometers. And in spite of this extension, it (optics) appears merely as a small appendage of the great domain of electricity. We see that this latter has become a mighty kingdom."

In spite of this prophesy, there is no question that even Hertz would be astounded by what has resulted. Indeed, only eight years later, the Italian scientist Marconi made the first successful attempt to generate such waves and use them for long distance communication.

But in spite of Maxwell's giant contribution, the problem of the



What is a wave?

If we drop a stone in a body of water, a series of waves spreads in circles from the point of origin. If we tie the stone to a rod and move it up and down a certain number of times per second or minute, we create a corresponding rythmic or periodic wave pattern in the water. But that's all it is, a pattern; a cork placed in the water would not move with the wave, but would merely bob up and down.

If we cut a "slice" out of the water, we see that the waves take the form of what is called a "sine" wave. The distance between crests is called the wavelength; the number of crests that pass a given point on their way out from the center is called the frequency and is normally measured in cycles per second. The faster the movement of our plunger, the more waves per unit of time and the shorter the distance from crest to crest—in scientific lingo: "high frequency, short wavelength."

A good example of the use of frequencies is seen on our radio dials: the numbers refer to the frequencies—in kilocycles (thousands of cycles) per second—at which the various stations broadcast. Short-wave radios are called that because they use shorter waves, i.e., higher frequencies. A short-wave radio dial is marked off in mega (million) cycles per second. So too is an FM radio. Light waves are much shorter still and have frequencies on the order of 100,000,000,000,000 (a hundred million million) cycles per second.

Electromagnetic waves consist of not one but two waves—an electric

ether still remained. And although the furor had perhaps abated somewhat, it was still generally accepted that an ether existed. One problem, however, was independent of the actual constitution of the ether and seemed to present no theoretical problems but to be merely a matter of experimental difficulty. This was the question of the velocity of the earth traveling through the ether.

Here was a wonderful challenge, and a wonderfully ingenious experiment was the result. If you throw a ball against the wind it travels more slowly than with or across the wind. If the earth is moving through a stationary medium such as still air, it is just the same as if this medium is moving past a stationary earth.

and a magnetic one—oriented at right angles to each other. Hence, fantastic as it may seem, if an infinitesimally small electric charge and an equally small magnetic pole were lying on this paper and a single light wave, as from a single electron, were shined on it, the charge would oscillate up and down and the pole from left to right (by analogy with the cork)—a hundred million million times a second.

It should be noted that all electromagnetic waves are produced by the vibration (or more specifically the acceleration and deceleration) of charged particles—mainly the electron. Naturally we can't see the wave produced by a single electron. A ray of visible light is made up of the waves, of many different wavelengths, produced by millions upon millions of electrons. But even waves of the same wavelength are out of phase. That is, the crests or maximum points of the waves do not all occur at the same time and place. The physicists say that the light is "incoherent." With the advent of the laser, however, we are able for the first time to produce "coherent" light, in which all the waves are similar and in phase.

Did I hear you say, "So what?" Well, let's pursue our hydrodynamic (water) analogy a little further. Suppose we had many small stones and dropped them at random into the water. The many small waves that would result would merely intermix and go off in all directions.

But if all the pebbles were alike, and if we could drop them, one at a time in the same place, so that each one hit the water just as a wave was forming, each wave would be reinforced and would rise just a bit higher, until finally we would have plenty of result (e.g., a wet floor).

Herein lies the power of the laser: the laser waves, all of which are exactly alike, act in support of each other, instead of merely intermixing and distributing their energy in a random fashion. The action starts with one wave moving down the length of the device. As it moves, it "kicks" other atoms which then emit waves exactly like it, *and* in phase with it. The wave bounces back and forth, building up greater and greater intensity, until it bursts out of one end—a narrow, very pure, and extremely intense beam of light.

The Michelson-Morley experiment was the most successful failure in the history of science. It showed nothing, yet won a Nobel physics prize.

Hence it should be possible to measure the velocity of light (analogous to the velocity of the ball) in the direction of the earth's motion and across it. The difference between these two velocities should give us an indication of how fast the earth is moving through the ether.

The result of the experiment, performed by the American physicist Michelson in 1881, and again with a co-worker, Morley, in 1887, was probably the most successful experimental failure in the history of science. Michelson even received a Nobel prize in physics for it. Yet the results showed nothing—absolutely nothing. There was no difference in the velocity of light with and across the ether wind.

Conclusion: no ether. Result: confusion compounded.

There were numerous attempts to explain, or explain away, these negative results, still without giving up the ether. Finally, in 1905, Einstein proposed a radically different approach to the problem. He showed, in effect, that the scientific community had been careless—that it had argued in a circle, and had created unnecessary confusion.

Einstein explained the null result of Michelson's experiment simply by returning to the principle (not the theory) of relativity, which states explicitly the impossibility of detecting absolute motion in space. (Without astronomical observations, we would never have been able to learn that the earth is moving through space.) Thus even if there is a material ether filling space, the experimenter would be unable to measure the velocity of himself relative to it; for all practical purposes the ether is unobservable. All we can certainly say is that if it does exist, it is of no interest to us.

This, in different form, is one of the two postulates of Einstein's famous, and well established, Special Theory of Relativity.

The ether was regarded as the supreme catalytic agent in 19th century physics. (A catalyst aids or hastens a chemical action without itself entering into the action.) It directed the course of development in both optics and electromagnetic theory along the right lines, only to disappear in the 20th century.

Resolution of the contradictions found in classical or Newtonian physics led in the hands of Einstein to entirely new and far reaching concepts of space, time and matter in his theory of relativity. In like manner, the classical laws were unable to account for many simple, clear experimental results concerning the behavior of atomic systems, and were replaced by the quantum theory.

In 1905, Einstein (he was busy that year) extended an idea proposed earlier by Planck and postulated that the energy in a light beam, instead of being distributed through space in the electric and magnetic fields of an electromagnetic wave, is concentrated in small packets or quanta of energy called "photons." This sounds like nothing more than a return to Newton's corpuscular theory; however, an aspect of the wave picture is retained in that a photon is still considered to have a frequency which is strictly a wave phenomenon. The higher the frequency of the photon, the higher its energy.

In the atomic domain, the quantum theory has been as revolutionary as was relativity in its impact on our concepts of nature.

The wave and the quantum theories of light complement each other and the "true nature" of light is no longer a meaningful concept. In problems where the propagation of light is concerned, it behaves *as if* it were an electromagnetic wave, while in the interaction of light with matter it behaves *as if* it were an assemblage of particles.

Further, the "mechanical" explanation of nature is finally seen to be an artificial and unnecessary idea. Indeed, there has arisen a type of man who thinks of the electrical quantities as fundamental and familiar, and for whom, as Einstein and Infeld put it, "The electromagnetic field is . . . as real as the chair on which he sits."

Maxwell's discovery is comparable in its importance to Newton's discovery of the law of gravity (see *Science Digest*, May 1964). Newton connected planetary motion with the phenomenon of gravity on earth. Maxwell connected optics with electricity and discovered the fundamental laws that govern the behavior of electric and magnetic fields and their interaction with charges and magnets. With Newton's work the concept of universal gravitation was introduced; Maxwell established the concept of the electromagnetic wave and its propagation in space. Newton's work had a profound influence on the general course of science. But even within our own lifetime, Maxwell's work has exerted profound changes in the lives of every one of us.

300 feet below the Mediterranean

Six Frenchmen will spend two weeks of this summer living in a specially built bathysphere more than 300 feet below the Mediterranean in the third of a series of experiments organized by Commander Jacques-Yves Cousteau, the French underwater explorer. The experiment will take place off the Ile du Levant on the French Riviera and the men will live in a bathysphere about 20 ft. across. Their reactions to life will be studied by a team of scientists. They will be able to leave their underwater "house" to explore marine life around them. In a similar experiment in the Red Sea in 1963, five men lived for 29 days in a submarine "village."

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How your body can shape your personality

The way you behave, new studies indicate, can be influenced not only by chemicals and shock treatment but also by physiological factors.

by Robert Mines, Ph.D.

UNTIL recently one factor basic to shaping our personalities has been almost ignored. Now students of human behavior have come to the conclusion that emotional influences are largely secondary to physical factors in determining the way we act.

Just how drastically we have under-estimated physical influences is indicated by an intensive study recently completed by two New York psychiatrists, Dr. Stella Chase and Dr. Alexander Thomas.

Over an eight-year period, Drs. Chase and Thomas compiled a detailed record of the behavior characteristics of 136 children. They concentrated upon nine major types of behavior—for instance, intensity of reaction to noise or light, ways of responding to new situations, ways of responding to attention from others—which could be observed from infancy and then repeatedly checked in later years.

While striking individual differences were found in each of these from child to child, the pattern for any particular child for each type of behavior was found to be consistent through the years of

The different ways that our body cells react to various nutritional elements play a key role in determining our emotional stability.

the study. This was true despite the fact that the children had known widely varying parents, discipline, degrees of emotional security and social circumstances.

While patterns of behavior may be modified by parental influences —or other external forces—Drs. Chase and Thomas have concluded that basically they stay as established personality facets throughout life.

No reputable scientist, of course, claims that personality traits are shaped entirely by physical factors. But it appears that they do set limits upon personality development—and that when personality disturbances occur, it may well be the result of some physical malfunctioning.

What body processes are most significantly involved?

Functions of the brain: Certain areas of the brain—for instance, the thalamus, the hypothalamus, and those sheets of tissue over the thalamus called the roof brain—are known to have marked effect upon our emotional stability. But what isn't so well recognized is the comparative ease with which the functions of these brain areas can be disturbed—a discovery of great significance regarding various kinds of emotional turmoil or stress. It takes a large dose of chloroform to upset the breathing reflexes, for instance, but only a tiny one to reduce or even stop the activity of these parts of the brain.

Individual differences

People also vary tremendously in the susceptibility their brains will have to various disturbing influences. Some persons, for instance, can retain their equilibrium under a concentration of alcohol, nicotine and sedatives that would render others helpless. This could help explain why some people experience certain emotional upsets that others can easily withstand.

Just how important a role brain disturbances can have in certain widespread emotional disturbances has recently been demonstrated by Dr. Nathan S. Kline, director of research at Rockland State Hospital, Orangeburg, N.Y. His experiments show that no form of psychotherapy has any significant effect on one of the most widespread emotional ailments, depression—the name given to an extreme, and usually, inappropriate grief reaction. On the other hand, certain physical therapies—electroconvulsive therapy, for instance, and drugs such as the still-experimental one called *marsilid*—have been proved to overcome depression effectively.

Exactly how electro-convulsive therapy returns certain brain functions to normal, which is evidently what it does, has not been clearly established. Nor has it been demonstrated why electro-convulsive therapy and insulin convulsive therapy, as well as certain drugs, stack up as the only proven therapies for schizophrenia, the most widespread of all mental illnesses.

But it is clear that they have a regulatory effect upon the nervous system. The physical factor in serious emotional disturbances can no longer go unrecognized.

Response to nutritional elements: Most medical researchers are now convinced that the biochemical differences between humans also play a major role in susceptibility—and resistance—not only to disease but, to a very large extent, to alcoholism and other addictions, certain emotional upheavals, and different behavioral traits as well.

Dr. Roger J. Williams, director of the Clayton Foundation Biochemical Institute at the University of Texas, has demonstrated, for instance, that the different ways that body cells react to various nutritional elements play a highly important role in emotional stability.

He has even found that the appetite-regulating cells of the brain vary greatly from one person to another. Some people will react quite normally to alcohol while others will develop a poisonous reaction to it, and still others will become addicted. But Dr. Williams has also found that certain nutritional supplements will cause the craving for alcohol to be totally eliminated.

But he does not encourage hopes for an all-inclusive prescription of food supplements suitable for every alcoholic (or for that matter, for any other type of personality disturbance arising from a similar cause). Instead, the particular food supplements needed by any alcoholic will vary greatly from one person to another, depending upon his own individual biochemical make-up.

Dr. Williams is only one of the many biochemists currently pursuing research along these lines. Nutritionists have long insisted that a stronger relationship exists between nutritional elements and personality stability than most of us recognize.

Regulatory functions of the endocrines: Not only may carefully-prescribed food supplements have a corrective role in behavior disorders but research has now proved that hormones can have a similar effect. New discoveries about the use to which synthetic hormones can be put along this line are astounding.

The eight endocrine glands are among the most complex body parts. Their secretions, hormones, circulate in the bloodstream in tiny amounts, but nonetheless have immense effect upon human behavior. (The thyroid gland, for instance, produces no more than a teaspoonful of hormones in a year.

Sex hormones have been found to be increasingly important in warding off unpleasant personality changes that are associated with old age.

But if in any newborn infant the teaspoon is only nine-tenths filled, that baby will be a malformed imbecile.)

One of the most important functions of hormones is the regulatory effect they have upon body parts—particularly when those parts are in trouble. When the body faces danger, for instance, not only will the hormones of the adrenals vastly increase—for one thing, to give the body increased energy—but there will even be a speed-up in the clotting time of the blood. Medical researchers have already proved synthetic hormones to be successful against at least 100 types of body malfunctioning.

Sex hormones have been the subject of intensive research. Most of the personality changes associated with growing old result from hardening of the arteries. Unfortunately, this will occur with some people long before it is expected. These changes cause memory loss, irritability, unusual sensitivity and any number of other alterations in long-established personality traits.

Now researchers have discovered that doses of female hormones may ward off hardening of the arteries—and the resulting personality changes in both men and women.

For their part, male sex hormones have been found to have a really amazing role in restoring normal energy. Only recently have scientists begun to fully appreciate the part that the body's energy-level plays in our personality traits. In more ways than we can list here, the degree of energy we have will determine what sort of social and emotional persons we will be. It affects our emotional stability, our persistence, the degree of optimism we bring to any situation, our tendencies toward depression and the degree of interest we have in what goes on around us.

Proteins determine energy

The energy we possess depends upon the utilization of protein by body cells—which means that protein must not only be available to the body but that the body cells must be able to use it once it reaches them. And medical researchers have now discovered that in certain instances in which body cells fail to utilize protein properly, injections of testosterone—the male sex hormone—will correct the situation. Again, it has been found that this works for both men and women.

Apparently sex hormones have a regulatory effect upon some body processes which have almost no relationship to our sex lives. Some scientists now predict that in years ahead, injections of sex hormones will be used to overcome an un-

dreamed-of range of body deficiencies—many of which will lie at the root of various emotional conflicts and behavior upheavals.

What immediate significance do these discoveries have for you and me? First we must realize that the more serious a personality disorder we may experience, the less we should count upon purely psychological means of overcoming it.

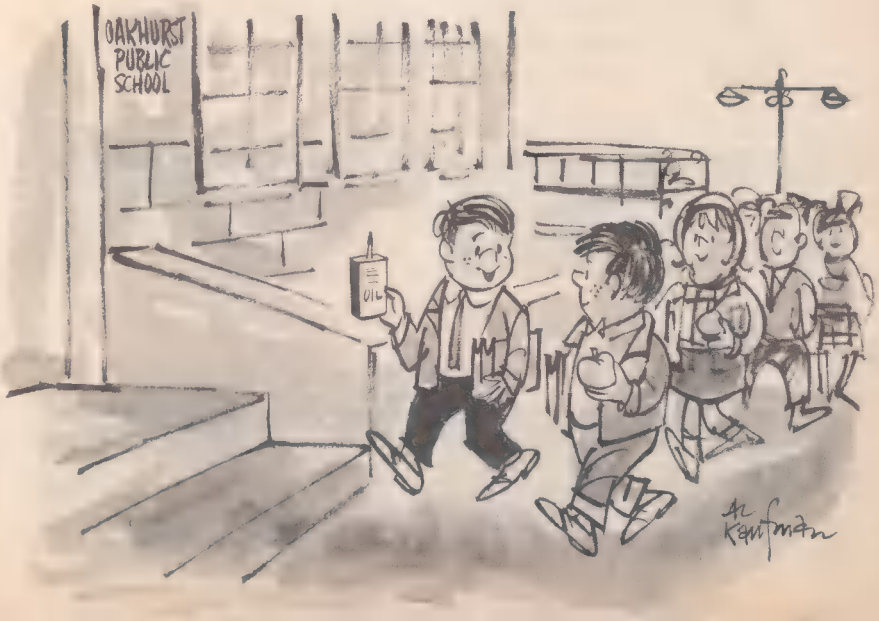
This is likely to be true also with any persistent emotional problem. Purely social or environmental factors may well bring on only transitory personality upsets—well below the level of mental illness or even serious neurosis.

But this doesn't mean that, because many troublesome personality factors seem conditioned by physical elements, we should adopt a fatalistic attitude toward reducing or improving them. Minor traits of this kind can probably always be controlled by anyone sincerely intent upon doing it. And the fact that physical elements are very much involved in the more serious personality disturbances indicates possibilities for overcoming them such as have never existed before.

People have often hesitated to seek treatment for these problems, for fear it would prove lengthy, disturbing, and, all too often, futile. Increasingly, this will be no excuse for deferring seeking help. Treatment will be more thoroughly scientific—and as a result, more efficient.

Discoveries occurring in this field almost seem to be those of a new science. Its future developments may surprise the world.

"It's for the teaching machine."

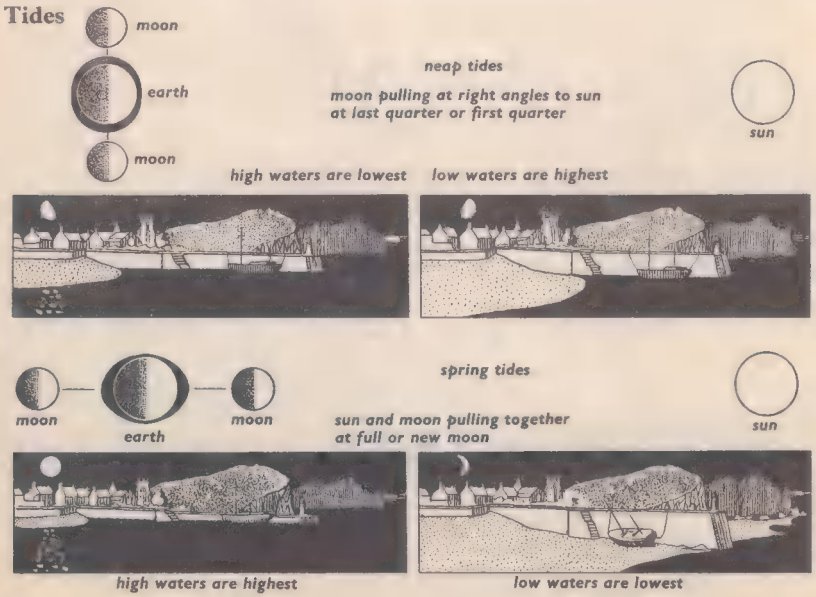


SCIENCE ABC's

Tides: the moon's pull on the sea

THE tides are caused by the gravitational attraction between the earth and the moon, with lesser effects caused by the sun. We often say that the moon revolves about the earth, but a more accurate statement is that both the earth and the moon revolve about their common center of gravity. If the earth and the moon were equal in weight, their common center of gravity would be the point in space half-way between them. But the earth weighs about 80 times as much as the moon, so that the center of gravity is much nearer to the center of the earth. It actually lies within the earth, about 100 miles beneath the surface.

The moon revolves about this point, while the earth "wobbles" about it on the opposite side, so as to balance the moon. It is rather like a fat man swinging a small boy around by his arms. The boy makes a big circle around the man, but to keep his balance the man has to lean slightly backwards and so makes a small circle himself. Now, suppose that the man is not holding



the boy's arms, but that the boy is holding the man's coat lapels. As he swings round, his weight pulls the man's coat out in front, and at the same time the man's coattails fly out behind. If you think of the boy as the moon and the man as the earth, you will see how the pull of the moon raises a high tide on the side of the earth facing it, while another tide—represented by the man's coat-tails—is flung out on the opposite side of the earth.

This is a good comparison as far as it goes, but now we have to imagine that the man has no arms but is a sort of human top, spinning round and round inside his coat much faster than the boy is swinging around him. This represents the earth spinning on its axis once every 24 hours, while the moon goes around the earth only once every month. Anybody standing on the earth passes by the high tide facing the moon every time he goes around, and he also passes by the other tide on the side opposite to the moon when he is half-way around. So he experiences two tides every day.

Thus, in the open ocean we should expect a high tide when the moon is high in the sky, and at the same time there should be another high tide on the opposite side of the earth. This happens in some places, but in others the large land masses throw the timetable out. At high tide in the open ocean the water rises only about a foot and ships do not notice it. As the moon crosses the sky the tides move across the face of the earth, but fortunately the water of the oceans does not flow—it is only the heaped-up shape of it that moves. As the tide at one place falls, the tide at the next place rises; then that falls and the next place rises, and so on. It plays a game of "pass-it-on" around the earth. However, when the tide enters a narrow channel there is so little room for the water that it is forced to rise more than a foot, and then it flows forward as a tidal current. In the English Channel the tide rises about 16 feet, and the tidal current flows at about 4 miles per hour. In Canada's Bay of Fundy, the tides rise more than 40 feet and send a four-foot wall of water—the famous Bay of Fundy tidal bore—rushing up narrow arms of the bay.

The sun also raises slight tides in the same way as the moon, but they are much feebler because the sun is so far away. At times of new and full moon, the sun and moon work together and we get the extra high "spring" tides. When there is a half-moon the sun's high tide comes at the time of the moon's low tide. and so they work against each other and we get the lesser "neap" tides.

The tides affect the land and air, too. Twice daily, in response to the tug of moon and sun, the continents bulge ever so slightly and the atmosphere bulges many miles out toward the moon and sun. But we cannot see or feel these "tides."

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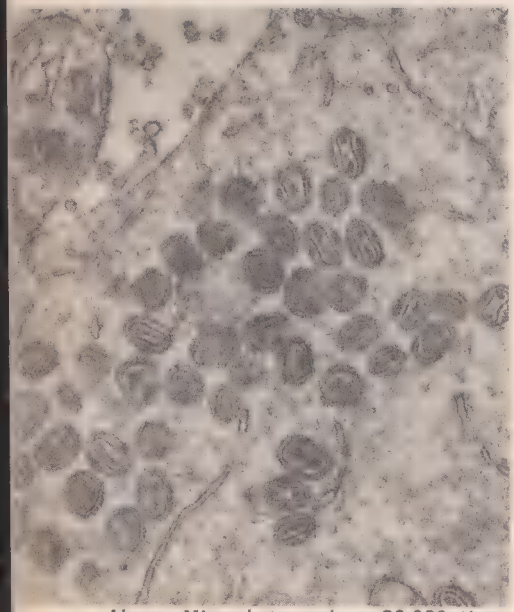
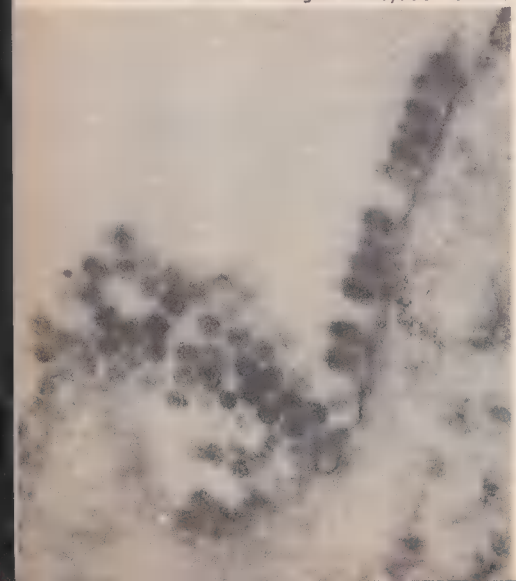
Viruses: smallest bits of living matter



Above: Microphotograph, a 90,000 times enlargement, of vaccina virus used in vaccination against smallpox. Below: influenza virus enlarged 140,000 times.



When we say bacteria, we think immediately of bits of life so small they cannot be seen without a microscope. But there are bits of living matter even smaller than bacteria. These are the viruses. Actually, viruses can vary greatly in size. Large ones may be as much as a hundred-thousandth of an inch in diameter. Very small ones may have a diameter of less than a millionth of an inch. On the average, viruses are a hundred times smaller than bacteria.

"Filterable viruses"

Viruses were originally called "filterable viruses" because they can pass through filters whose pores stop ordinary bacteria. Back in 1892 a bacteriologist who was investigating a disease of tobacco plants called "tobacco mosaic" found that he could infect healthy tobacco plants with the disease by rubbing them with juice obtained by grinding up leaves from sick plants and passing the juice through a filter that stopped bacteria. Plainly, something smaller than bacteria was going through the filter and spreading the disease to the healthy tobacco plants.

This brings up a most important point. A great many viruses cause disease—so many that the first thing researchers do when a new virus is discovered is search for a disease it might cause. The reason

why viruses are closely connected with disease is that they are "obligate parasites." This means that they do not lead an independent existence, but can live only inside living cells. A virus must infect something in order to live. This is due to the fact that viruses lack much of the chemical machinery needed for life. They must literally steal it from other, more complete organisms, such as bacteria or higher forms of life.

Viruses have been difficult to study both because they are too small to be seen under an ordinary microscope and ordinarily can be grown only in living cells. The invention of the electron microscope, however, has made it possible to obtain beautiful photographs of viruses.

Grown in test tubes

Researchers have learned to grow many different kinds of viruses in living cells grown in test tubes. As a result, many hundreds of different viruses have been discovered in the past few years. There are viruses called "bacteriophages," that attack bacteria; viruses that attack plants; and viruses that attack animals, including man. In man, viruses cause such diseases as the common cold, influenza, grippe, measles, German measles, polio, smallpox and yellow fever.

A curious feature of diseases caused by viruses is that drugs do not help much in curing them. This is because signs of the disease do not appear until the viruses responsible for the illness have already gained entrance to the patient's cells and injured or destroyed them. In other words, we do not know that we are ill until the damage has been done.

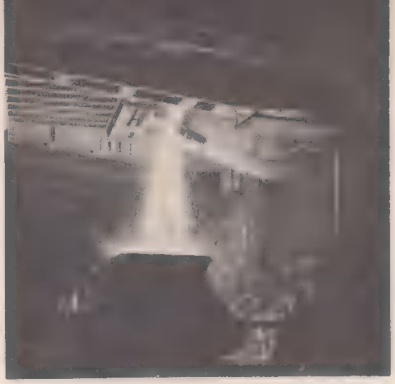
In diseases caused by bacteria, the situation is not quite the same. Bacterial diseases often cause symptoms while the bacteria are still in the bloodstream, for instance, where powerful antibiotic drugs can get at them.

But we are by no means defenseless against viruses. Special tissues located in lymph glands scattered throughout our bodies can form chemical substances, called antibodies, that neutralize viruses and render them harmless.

Moreover, the body can be induced to form antibodies against disease viruses by injections of killed viruses or harmless viruses resembling disease viruses. Preparations containing killed or harmless viruses designed to make one immune to a disease are called "vaccines."

Some vaccines can make one immune to a disease for a short time only; others give protection for many years.

We now have excellent vaccines against smallpox, polio and yellow fever, to mention just a few.



KFS

Steel making is one of the most important and spectacular industrial operations in the world.

Do you know your metals?

by John and Molly Daugherty

METALLURGY is the science of obtaining metals from their ores. How much do you know about it?

1. Which one of these non-Communist countries has the greatest reserves of uranium oxide ores?
   a. South Africa
   b. The United States
   c. Canada

2. In powder metallurgy, metal in powder form may be compacted under high pressure without the high temperatures sometimes required to melt it. A unique application of powder metallurgy is found in:
   a. The making of bottle caps
   b. Oil-less bearings that are self-lubricating
   c. Large-sized structural parts

3. Which one of these metals was first used as a filament in electric lamps?
   a. Platinum
   b. Osmium
   c. Tungsten

4. For which of these elements was zone refining first used to prepare a sample of high purity?
   a. Uranium
   b. Titanium
   c. Germanium

5. In non-ferrous metallurgy the first step is to
   a. Crush and screen the ore
   b. Remove waste and concentrate the ore (beneficiation)
   c. Draw air or coke dust through layers of ignited material to burn off sulfur (sintering)

6. Which of these non-ferrous metals has had the most spectacular rise in production since its commercial introduction?
   a. Aluminum
   b. Copper
   c. Lead

7. Some ores, especially those in Europe, contain harmful phosphorus which the earliest Bessimer steel converters could not use. The successful use of ores with high phosphoric content became possible when:
   a. Manganese was added to the melt to absorb phosphorus
   b. The phosphorus was burned off by increased heating
   c. The converters were relined with dolomite instead of silicious material

8. Which of these three metallic elements is the most abundant in the earth's crust?
   a. Copper
   b. Titanium
   c. Lead

9. **When and by whom was the element uranium named and thought to have been isolated?**
   - **a. In 1789 by Klaproth**
   - **b. In 1840 by Peligot**
   - **c. In 1897 by Becquerel**

10. **Metallography in its early development in metallurgy referred to**
   - **a. Microscopic observations of metals**
   - **b. Spectroscopic observations of metals**
   - **c. Graphical methods of showing stress in metals**

Answers:

1—c Canada. Some estimates list Canada with reserves of over 400,000 tons of uranium oxide; the United States, with over 200,000 tons; and South Africa, with over 300,000 tons. Production in some years has run as follows: the United States, 18,000 tons; Canada, 15,000; and South Africa, 6,000.

Uranium as an element is quite abundant in the earth's crust, however. If low grade ores are included, the United States may have reserves of uranium ores as high as 6,000,000 tons out of a world total of 25,000,000 tons.

Rich finds of pitchblende ores containing radium and uranium were made in Canada in 1930, with further discovery of vast uranium ore deposits in 1953.

2—b Oil-less bearings that are oil-impregnated. The general idea was invented in 1870 by Gwynn. He pressed various metal powders with an added lubricant. Later, Gibson pressed copper and tin oxides and reduced the oxides to bronze. In use, the rather spongy mass of the bearing heated up and released the lubricant. On cooling, the porous bearing reabsorbed the lubricant. The devices in improved forms are widely used in machinery, and more recently, by the automobile industry.

3—b Osmium. Before tungsten was successfully drawn into wire, Welsbach, an Austrian, applied powder metallurgy to osmium in 1898. Using a gum material, he mixed powdered osmium with a binder. After extruding the mix to get elongated pieces, he heated them in an atmosphere of hydrogen to get rid of the binder and at the same time prevent oxidation of the metal. Further heating (sintering) of the fragile wire took place in the vacuum of the light bulb. Early use of this method failed, but by 1908 ways were found to increase the ductility of tungsten and draw it into wire at room temperature.

4—c Germanium. Soon after the semi-conducting properties of germanium were put in crystal diodes, the Bell Telephone company in 1948 developed a triode (or transistor) to amplify in the same way a radio tube does. Traces of impurities in germanium, even a few parts in a million, hinders its use in electronics.

In 1952, Bell Labs. introduced zone refining. A long bar of the metal was heated in a quartz tube in an atmosphere of an inert gas. As the metal progressively became molten from one end to the other, impurities concentrated in the molten portion, leaving the recrystallized part almost free from impurities. Successive trials swept impurities to one end, which was cut off. This process is known as zone refining.

5—b Beneficiation. The flotation process of beneficiation is the most important, especially the selective flotation method.

Ore is ground in water to separate the mineral content from waste material. Then the mix is agitated with air bubbles (helped by various chemical reagents) so that the minerals cling to the air bubbles. Oil is also used in the bulk flotation process.

Since 1920, selective flotation processes have been used to remove the sulphides of a number of different minerals from the same ore material. In this way, many low grade ores can be economically processed.

6—a Aluminum. Commercial production started in 1888, and the world production is now over 5,000,000 metric tons. The United States accounts for nearly half of the output. In 1963, the United States production was about 2,300,000 tons.

World production of copper is a close second to aluminum, amounting to nearly 5,000,000 metric tons, with the United States producing 1,200,000. World production of lead is only about half as much as that of aluminum and copper.

7—c Relining with dolomite, which has basic qualities, rather than acidic properties. Lime was also added to the slag and helped to hold the phosphorus or remove it from steel.

Manganese was added—about fourteen pounds a ton—to the charge in the Bessemer converter. Without this deoxidizer, Bessemer steel was of very poor quality.

8—b Titanium. There is sixty times more of it than copper, and four times more copper than lead.

Metallurgical difficulties in producing metallic titanium from its ores, except for experimental amounts, delayed industrial production until after 1940. By 1948 about one hundred pounds a day was being produced in the United States at the price of $5 a pound.

Various alloys of titanium are suitable for aircraft construction because of high strength, light weight, and ability to withstand high temperatures without change.

9—a In 1789, Klaproth isolated a black powder he thought to be a new metal from pitchblende. He called it uranium in honor of Sir William Herschel's new planet Uranus, discovered in 1781.

In 1840, Peligot showed that Klaproth's black powder must actually have been an oxide of the new element. By 1842, Peligot prepared the first metallic uranium.

Becquerel, in 1897, discovered that uranium is radioactive—just a year before the Curies discovered radium in pitchblende.

10—a Miscroscopic examination. In the 1860's, Sorby in England studied the structure of metal surfaces under a microscope using reflected light. His work was the beginning of metallography.

Score Yourself:

9—10 right—You've proved your metal!

4— 8 right—Your score's an alloy.

0— 3 right—A lack-lustre score this time.

The Hugh Downs Column

Don't ring, I'm already awake

It happened again day before yesterday.

I awoke with a premonition that my alarm clock was about to go off, and while I was reaching out to turn it off before it could start ringing—it rang.

If this only happened once, or once in a few years, or if it happened only to me, I would not regard it as a phenomenon for speculation or investigation, but it happens so often, and to so many people, that it's worth a short examination, particularly since there are so many unsatisfactory explanations for this occurrence.

There are variations of the event. Sometimes I awake, and feeling the familiar urgent need to turn off the alarm before it rings, I successfully do so, only to hear within a second or two the click that indicates the alarm-triggering mechanism has discharged and the alarm would have gone off if I hadn't just prevented it.

Of course, it doesn't happen every morning. Often I awake murkily, struggling up through a confusion that brings a dim awareness that the alarm has been ringing for some time. On rare occasions, I'll awake suddenly, with the familiar urgent feeling, confident that it's near the time I set the alarm to get up, only to find that it's two or three hours before that time. So anticipating this unwelcome clangor is by no means a consistent thing.

But withal there seems to me (and to many others) a mysterious and inordinate f r e q u e n c y with which the "inner voice" wakes one and hits the time right on the button. Why? Here are some of the explanations:

1. We possess a subconscious "clock" mechanism in the brain, which not only doesn't sleep but

Does man's subconscious have a chronometer of great accuracy, which counts off the seconds from the moment he snoozes until he awakes?

possesses accuracy far keener than any conscious attempts to estimate passage of time.

2. We possess a clairvoyant ability to sense the condition of a piece of machinery and the imminence of its discharging some event.

3. It's all a complete coincidence. Nothing else.

4. There are subtle changes in the ticking sound emitted by a clock on the verge of ringing its alarm bell, and this alerts the sleeper.

Let me make clear that I don't postulate this as a necessarily true phenomenon worthy of vast attention, and I haven't undertaken exhaustive research into the extent of scientific opinion on this sort of thing.

What I want to do here is approach the problem scientifically to see what conclusions, if any, might be reached on the basis of pure personal experience (not unique to the writer).

First of all, does it happen often enough and close enough to the exact target time to prevent easy dismissal as coincidence? I can only say it seems so to me.

Six hours of sleep is 21,600 seconds. If your tendency is to awake at the end of six hours, and you hit within ten minutes of the time with any frequency at all, your chemical processes in replenishing and refreshing the body possess a pretty good rate, in watchmakers' terms. (Whether a watch loses or gains is unimportant to its rate, nor is it important how much it loses or gains. Rate is determined only by its consistency of gain or loss at a certain speed setting. The consistency is the measure of its rate.)

Ten minutes is only 600 seconds, which is 1/36th of the six-hour sleeping time. To hit within this fractional limit would indicate considerable consistency of body chemical processes.

Split seconds

But we're not talking about 600 seconds. We are faced with something that seems to happen with puzzling frequency within one to ten seconds. Sometimes almost on a split-second basis.

The favorite explanation seems to be the first one: that man's subconscious has a chronometer of great accuracy, which counts off the seconds from the moment he snoozes till the moment he awakes almost with greater accuracy than the Naval Observatory at Arlington.

I am not a detractor of the Excellence of Man, but this idea as an explanation of the alarm clock mystery has some holes in it. Let's suppose the human brain, on some deep level, has these exalted properties.

First off, where are they when we need them? Why would we ever hear the astonished exclamation, "I had no *idea* how late it was!" Why indeed would we hang clocks and wear watches?

Human chronometer

Secondly, even if this ability exists, and is operative when consciousness is quiescent and not confusing things, what is its basis of starting? True time, to the most accurate source of which it may or may not have had access? The time indicated by the alarm clock at the moment of setting? What is its point of departure? Suppose it knows to the second what the clock really reads at the time the alarm is set. Can it know the speed of the clock—that is exactly how much slower or faster than time this particular clock runs? And can it know the rate? Whether the "fastness" or "slowness" is consistent throughout the six hours? (In other words, is the average alarm clock consistent in its time-keeping? Is it so consistent that the Great Subconscious Human Chronometer, even if exactly matched to the clock's rate at time of setting the alarm, could count on that same rate to the time of ringing with such accuracy that it could nudge the sleeper at T-minus three seconds?) It doesn't really seem too likely.

This would suggest the second hypothesis: That some sort of clairvoyance exists to monitor exactly how the clock is doing at any given moment and to know how near it is to setting off its alarm. While it would be un-scientific to dismiss such a possibility, it is safe to say no satisfactory evidence exists to make a case for any clairvoyance in this or any other instance.

Lets look at No. 3. There are coincidences. Chance provides for them and the existence of them does no violence to scientific fact. Random events seem to follow probability laws. But human participation in events at times appears to distort the laws enough to produce something mysterious. My opinion is that the alarm clock phenomenon occurs frequently enough to be unexplainable as pure coincidence.

Time-estimating ability

A rough calculation (mixed with shrewd guesswork) shows that average human time-estimating ability (assuming it operates while we sleep and would tend to waken us as near target-time as it could) interacting with chance might hit within ten seconds after six hours once in 60 times when it was in operation at all. This is assuming a better ability to guess elapsed time than I possess, asleep or awake. Even so, there would be more times when it scored within, say, one minute than within ten seconds.

But in my case I seldom hit in the area of one minute each side of an alarm's ringing. *If it happens at all*, my anticipation is more likely to happen well within 10 seconds and sometimes within a second or less of

my initiating action to forestall the ring.

And this is not after years of acquaintance with the characteristics of the same clock. I use different clocks set at different times after different durations.

A given clock is usually not a paragon of chronometric accuracy in ringing at the precise time it is set to ring. I have experimented with some clocks and found that usually a clock will not trigger at exactly the same reading at any two times even with the alarm indicator in the same identical position. The mechanism is simply not that precise.

Bureau-of-Standards accuracy

So even if the brain possessed this Bureau-of-Standards accuracy coupled to an Early Warning Device, it would not work with the average alarm clock. And there goes another theory.

Now No. 4. This has always seemed to me the most plausible: that a clock makes some noise and that something about this noise changes enough to indicate in some way that it is on the verge of sounding its alarm. However subtle this change might be, it needn't strain crudility or offend scientific orthodoxy to propose that a human sleeping near a mechanical clock could hear this difference and be conditioned to interpret the information and to react to it. But I've experienced it with relatively new clocks, both wind-up and electric, the latter as near silent as the advertisements claim.

And more than once I had the experience of being in another room and with sufficient background noise (running water) to obliterate any clock sound, and thinking that I might make it back to prevent an alarm ringing, only to succeed or miss by a margin ranging from two or three seconds down to a split-second. Here the preminition was enough in advance to allow for walking from one room to another, but only *that much* in advance.

And there have been times when I have had the certainty that a hotel switch board operator was on the verge of ringing to tell me that it was the time I had asked her to ring, even though she may have been several minutes off. Here again the possibility remains of a subliminal preparatory sound from the telephone. When a connection engages a ring cycle at the very tail end of one ring, sometimes just enough voltage surge comes through the bell coils to activate the clapper without actually ringing the phone bells. If this is what warns us, we have formidable sensing and interpreting machinery inside our skulls. I don't deny this.

But as formidable as I can make it in my imagination, there are residual mysteries in the case of the waking sleeper. If I get answers to any of these, I'll publish them in a subsequent column. Meantime, I'd welcome speculation, theories or facts from anyone who has experienced these phenomena.

From the White House

It was thoughtful of you to send the two copies of the *Science Digest* which contained the article by Flora Rheta Schreiber ("LBJ's 'Feel' for Science," April, '65). The President has long been familiar with Miss Schreiber's work and always enjoys having the opportunity to read one of her articles.

GEORGE E. REEDY
Press Secretary
to the President
The White House
Washington, D.C.

Psychology section

I have been reading *Science Digest* for several years now and enjoy it very much. Your magazine used to have a few pages devoted to psychology. I have been wondering what happened to the "What's On Your Mind" section. If it has been discontinued, I'm sorry, for I enjoyed it very much.

BRION CROWLEY
Jacksonville, Fla.

We now cover progress in psychology in the regular column "Inside Psychiatry Today" as well as in the occasional "This Month" feature, "The Psychology Story." And, of course, we often run full-length articles on developments in the field—Ed.

First TV

An answer to "Inventors Quiz" (March '65) says that "the first commercial TV went on the air July 1, 1941, on WNBT in New York."

If by "commercial" is meant public service televising, this is incorrect. There were TV programs for the public in Britain as far back as Nov. 1936, and I believe a limited German TV schedule was operating even before that.

J. F. LITTLER
Chicago, Ill.

Dolphin or porpoise?

Regarding Hugh Downs' "Dolphin" article (March '65):

The Navy research people call the critter a porpoise.

The producers of TV's "Flipper" do likewise.

So do 126,489 Gulf of Mexico anglers, to whom a "dolphin" is a pretty, snub-nosed, edible fish.

And, finally, Webster's Third New International 1964 Unabridged Dictionary, defining "dolphin," says as "distinguished from porpoise."

Otherwise, the article was great.

JACK GOULD
Baton Rouge, La.

There is a great deal of confusion about dolphins and porpoises. In general, the word dolphin refers to any of a variety of small, toothed whales. More specifically, dolphin refers to the beaked species of small whale and porpoise refers to the beakless ones. Most work has been done with the beaked types. The Navy may call them porpoises, but other researchers call them dolphins (see Science Digest, *May '65). Porpoise is only Flipper's stage name. His true scientific name is* Tursiops

truncatus *or* Tursiops gillii, *depending on whether he is of the Atlantic or Pacific variety. Both types are most commonly known as bottle-nosed dolphins.*

There is a game fish called the dolphin, but this merely compounds the confusion.

The dolphin (or porpoise) is not the only animal with a multiplicity of common names. Think of poor Felis concolor, *who is a mountain lion, cougar, panther and puma.—Ed.*

Transparent woman

The transparent woman shown on the cover of your March '65 issue and discussed in a story is manufactured by the Cleveland Health Museum and totally different from the one which we purchased from Germany at a considerably greater cost. We were also sorry to see our name mentioned as the Hall of Science and Industry rather than the Center of Science and Industry, which is our correct title.

Even though not totally correct, we do appreciate the mention of the Center in your publication.

S. N. Hallock, Director
Center of Science and Industry
Columbus, Ohio

The model pictured on the March cover and discussed in the story is located, as we stated, in the Stark County Historical Society in Canton, Ohio. We do stand guilty in part, perhaps, for having stated that a model "like it" was in the "Hall" of Science and Industry in Columbus. —Ed.

Layman's language

I am happy to say I have discovered *Science Digest.* It is rare that anyone has the forethought to print science stories in layman's language. There are many of us who would like to understand new scientific theories. Thank you for your contribution of easy to read and understand science news.

Dallas A. Martin
Torrance, Calif.

Faster than light

In your Feb. '65 issue you blandly assert that a blue glow, called Cerenkov radiation, seen in the water surrounding the TRIGA reactor is caused by particles traveling through the water at a velocity exceeding that of the speed of light in the medium. If that is true, you have just disproved Einstein's Theory of Relativity.

Michael S. Lasky
Brooklyn, N.Y.

In our statement that Cerenkov radiation occurs "when charged particles travel through water at a velocity exceeding that of the speed of light in the medium," the key words are "in the medium."

The theoretical speed limit in the universe of 186,300 miles per second is the speed of light in a vacuum. Light travels more slowly through various other mediums. The speed of light in water is about 75 percent of its speed in a vacuum.

Cerenkov radiation is similar to shock waves in air and waves in water. If an aircraft travels through air faster than the speed of sound, it tries to push aside the air particles faster than they normally move. A sonic boom results. If a boat moves faster than the normal speed of water particles, it builds up waves. Notice how a very slow-moving boat creates no waves.—Ed.

Satellite for you

WHEN the first Early Bird communications satellite (below, left) was successfully launched recently, Vice-President Hubert Humphrey quipped, "My goodness, now we'll be able to call everybody!"

Not quite yet, but that's the ultimate aim of a series of satellites of which the Early Bird was first.

Early Bird is the world's first privately owned satellite.

The owners are the Communications Satellite Corporation, known as Comsat. With private capital, Comsat was created by Congress to build a space communications network, make a profit, serve the public and further international understanding.

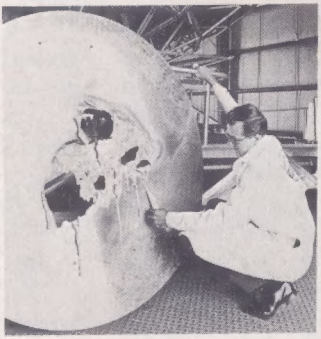
The hatbox-shaped Early Bird successfully passed the first tests of its ability to relay signals between North America and Europe (below, right). To provide worldwide coverage will require three such satellites properly positioned and each rotating at the same speed as the earth.

Comsat is studying two other types of satellite networks before making a final decision on which to use. One would employ 18 random satellites in low orbit. The second would place precisely positioned satellites in low orbit, so only 12 would be needed.

In this issue . . .

Not often is the excitement of modern science felt more keenly than at California's Scripps Institution of Oceanography. A picture story on how these scientists of the sea work begins on page 57.

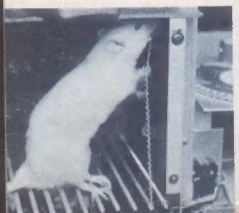
These men are wheeling atomic clocks. They took them all over the world. Why don't they just wear watches? See page 38.



Using the sun's rays and a magnifying glass, kids can burn paper. Scientists melt metal with the sun and a mirror. Page 52.

The Early Bird satellite is the first step in creating a privately owned world-wide communications satellite network. Inside back cover.

This is an unusual view of Cape Kennedy. Other unusual views of the Cape start on page 47.



You think you have troubles. Wait till you see what this rat has to go through to get a square meal in a psychology lab. Page 24.

Strange statues and great pyramids are all that remain of a mysterious people who ruled Mexico before the Aztecs. Page 62.